RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

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Vol. 70 MAY 1958 No. 5

Important Aspects in the Roentgen Study of the Normal Lumbosacral Spine

ISADORE MESCHAN, M.D.[2] and R. M. F. FARRER-MESCHAN, M.D.[3]

TO DISCUSS those aspects of the normal lumbosacral spine which may be pertinent to the subject of low backache is a particularly difficult assignment. The more usual aspects are familiar to mature radiologists; yet the normal is far more difficult to describe than the abnormal. A review of fundamentals, however, serves a useful purpose at all times.

It would seem that those aspects which are most important in this respect are, first, abnormalities in development and, second, the results of the weight-bearing stresses and strain which occur with growth and development, giving rise to aberrations in alignment.

DEVELOPMENTAL ASPECTS

Embryologically, the vertebral column develops in three stages: the membranous, the cartilaginous, and the ossific.

In the membranous stage (1) the axial skeleton first differentiates from the mesenchyme, most of which occurs in serially arranged pairs of mesodermal segments designated as sclerotomes. The sclerotomes migrate to lie in paired segmental masses alongside the notochord (Fig. 1). Each sclerotome differentiates into a compact caudal portion and a less dense cranial half. At alternate segments there is an intersegmental artery between a less dense and a compact portion. The denser caudal part of each sclerotome mass then unites with the looser cranial half and thus forms the substance of the definitive vertebra. The intervertebral disk differentiates from the denser caudal region.

This so-called membranous vertebral column is succeeded at about the fourth week of fetal life by the cartilaginous vertebral column. Two cartilaginous centers appear on either side of the notochord and rapidly extend around it, thereby forming the bodies of the cartilaginous vertebrae (Fig. 2). Second pairs of cartilaginous foci appear in the lateral parts of the vertebral arch and extend backward on either side of the neural tube to form the cartilaginous vertebral arch. Still different cartilaginous centers appear for each costal arch.

An aberration in the cartilaginous stage, of development, with persistence of a notochord remnant, produces the so-called butterfly hemivertebra (Fig. 3).

During the cartilaginous stage the notochord is progressively compressed into the central regions of the dense intervertebral disks. Eventually it disappears completely except as the nucleus pulposus of

[1] Presented as part of a Symposium on the Lumbosacral Spine at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

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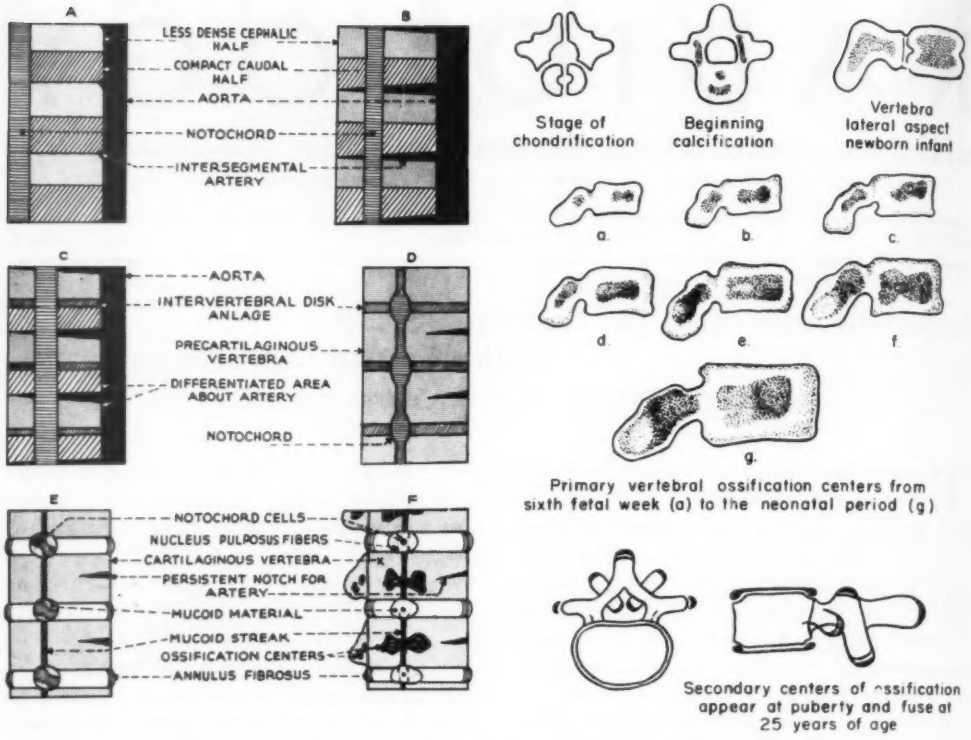


Fig. 1 (left). Development of the vertebral column as a whole, demonstrating the membranous, cartilaginous, and early ossification stages. Modified after Bradford and Spurling (1).

Fig. 2 (right). Further diagrams demonstrating the stage of chondrification, beginning calcification, and gradual development of ossification in the vertebral body of the newborn. Secondary centers of ossification which appear at puberty and fuse at twenty-five years of age are also shown.

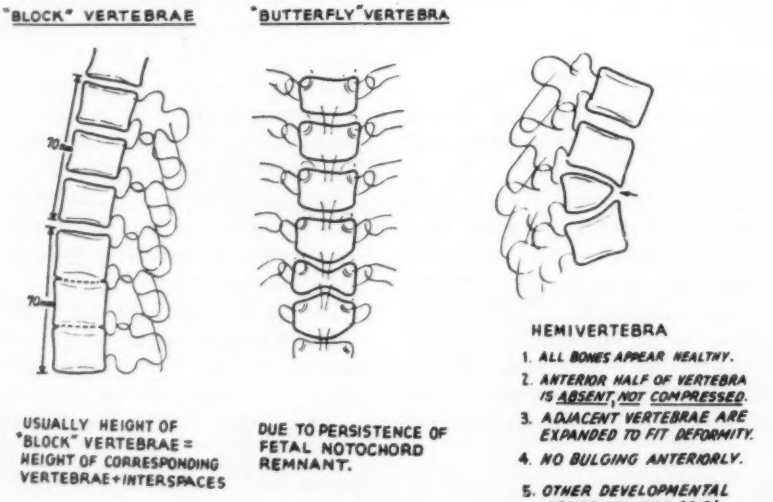

"BLOCK" VERTEBRAE
"BUTTERFLY" VERTEBRA
USUALLY HEIGHT OF "BLOCK" VERTEBRAE = HEIGHT OF CORRESPONDING VERTEBRAE + INTERSPACES
DUE TO PERSISTENCE OF FETAL NOTOCHORD REMNANT.
HEMIVERTEBRA
1. ALL BONES APPEAR HEALTHY.
2. ANTERIOR HALF OF VERTEBRA IS ABSENT, NOT COMPRESSED.
3. ADJACENT VERTEBRAE ARE EXPANDED TO FIT DEFORMITY.
4. NO BULGING ANTERIORLY.
5. OTHER DEVELOPMENTAL ABNORMALITIES (RIB) MAY BE PRESENT.
6. INTERSPACES ARE WELL PRESERVED.

Fig. 3. Various diagnostic criteria for "block" vertebra, a "butterfly" vertebra, and hemivertebra (5).

the intervertebral cartilage. The intersegmental artery persists as a narrow channeled anterior portal into the central portion of the vertebral body (Fig. 4). This appearance of the intersegmental artery produces an anterior notching of the vertebral bodies centrally, which may persist into adult life. Such persistence is probably without pathologic significance.

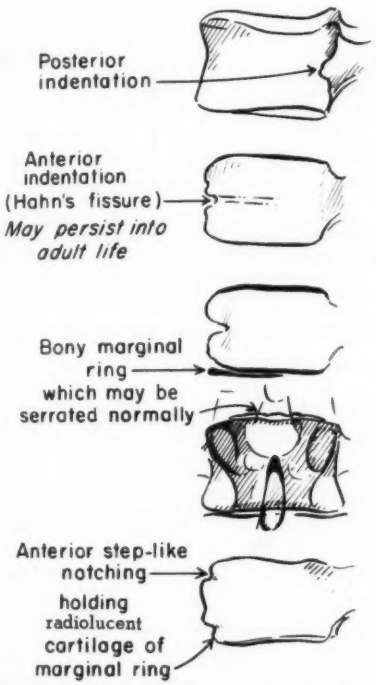

Posterior indentation
Anterior indentation (Hahn's fissure)
May persist into adult life
Bony marginal ring which may be serrated normally
Anterior step-like notching holding radiolucent cartilage of marginal ring

Fig. 4. The normal appearance of posterior and anterior indentations on vertebral bodies in relation to blood supply and venous drainage. The anterior step-like notching is a change in contour which is described in relation to the cartilaginous end plates of the vertebral body.

The anterior and posterior longitudinal spinal ligaments develop during the cartilaginous stage. In the ninth week of fetal life, anterior and posterior indentations into the cartilaginous body are produced by periosteal vessels, which form ventral and dorsal blood lakes (Fig. 5). These correspond with the arterial and venous supply to the vertebral bodies, as shown in the illustration.

There is considerable disagreement as to

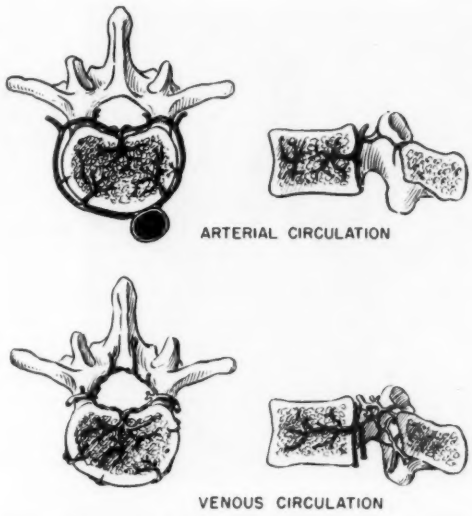


Fig. 5. Diagrams illustrating the arterial and venous circulation of a vertebral body and its neural arch.

the exact changes which occur during the ossification stage. Ossification centers are said to form either dorsally and ventrally, or superiorly and inferiorly, in the vertebral body and are separated by cartilaginous septa, which soon disappear (Fig. 2). In either instance, the primary ossification center is hourglass shaped, and abnormalities in ossification will account for various unusual wedged appearances of the vertebral bodies. One can usually differentiate such wedging from traumatic or infectious wedging on the basis of the overdevelopment which is often discernible in contiguous vertebrae (Fig. 3).

There are also separate ossification centers on each side which enter into the formation of the neural arch. Thus, for each vertebral segment there are three separate ossification centers.

Aberrations in the further development of the neural arch are usually considered to represent defects in the development of the ossification rather than abnormalities in the centers *per se*. Figure 6 demonstrates the various areas of defective ossification which can occur in the formation of the neural arch.

At approximately the fifth to the sixth month of fetal life, the ossification center

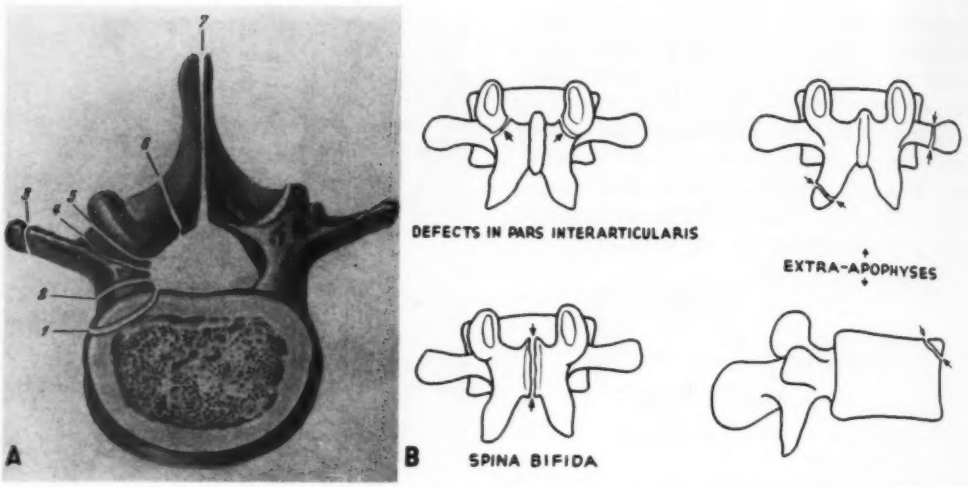


Fig. 6. A. Diagram illustrating the various areas for defective ossification in the neural arch and pedicles: 1. Retrosomatic hiatus. 2. Hiatus in the pedicle. 3. Persistent epiphysis of the transverse process. 4 and 5. Defects in the pars interarticularis. 6. Retroisthmic hiatus. 7. Bifid posterior spinous process. From: Köhler, Alban: Borderlands of the Normal and Early Pathologic in Skeletal Roentgenology. English translation by James T. Case. New York, Grune & Stratton, Inc., 1956.

B. Further tracings demonstrating defects in the pars interarticularis, spina bifida, and extra-apophyses as they may appear on various roentgenographic views (5).

of the vertebral body has separated the cartilaginous body into two thick cartilaginous plates showing endochondral ossification toward the intervertebral disk side. Along the anterior and lateral periphery of the vertebral bodies, horseshoe-shaped cartilaginous plates appear, which represent cartilaginous ring apophyses (Fig. 2). Later these form the anlage of the bony ring apophysis which appears in adolescent life. These apophyses fit into notches in the superior and inferior portions of the vertebral bodies so that, prior to the ossification of the ring apophysis, the vertebral body has a notched appearance (Fig. 4). The rami of the lumbar neural arches unite during the first year of life, and similar changes follow in the neural arches of the thoracic and cervical regions. The tips of the transverse spinal processes remain cartilaginous in the years before puberty. At about the sixteenth year, secondary centers appear at the tips of the transverse processes, the tips of the spinous processes, and at the upper and lower surfaces of the vertebral body (Fig. 2).

It should be recalled that union of laminae occurs in the lumbar region only after birth, and considerably later in the cervical region and sacrum. Union of the laminae of L-5 may be postponed until the fifth or sixth year of life.

There are perhaps two other aberrations of development in relation to the vertebral body and the intervertebral disk which are noteworthy. Very often there is a posterior wedging of the fifth lumbar vertebra which persists even into adult life. Such posterior wedging is a relatively normal contour variation and has no pathologic significance. It is related to the junction of the lumbar curvature with the sacral curvature. Also the intervertebral disk between L-5 and S-1 may be narrowed throughout life. This likewise is related to the junction point between the lumbar and sacral curvature. *Narrowness of the interspace between L-5 and S-1, therefore, is without pathologic significance unless there are some other radiographic criteria, such as sclerosis of the end plates, irregularities of the end plates, or changes in the adjoining ligamentous structures.*

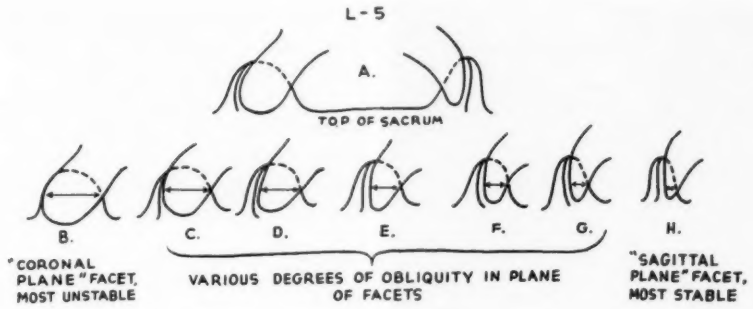


Fig. 7. Variations in the degree of obliquity in the plane of the lumbosacral facets, and their probable relationship to stability at this articulation (5).

THE SYNOVIAL INTERVERTEBRAL JOINTS

Two superior processes extend upward and posteriorly from each vertebral body to articulate with the inferior articular processes of the vertebra above. The joint between these two processes is a synovial joint subject to the many diseases of diarthrodial joints. In the thoracic region these joints lie in an almost true cephalocaudad plane, while in the lumbar area they are often tilted at an angle of about 45°, constituting a considerable portion of the supporting mechanism for the lumbar spine. The plane of these joints varies from individual to individual, and also from segment to segment, but ordinarily is so related to the sacroiliac joints as to be represented by an angle of 90 degrees between the two. It is probable that slight alterations in the plane, particularly between L-5 and S-1, are related in some patients to instability at the lumbosacral junction and low back pain (Fig. 7).

The intervertebral foramen is formed by the articular union of two contiguous vertebrae and constitutes the passage for vessels and nerves from the spinal canal. The integrity of this foramen must likewise be studied in every instance, since occasionally there exist at these levels pressure phenomena which are responsible for the clinical symptomatology. The shape should be uniformly oval. Encroachments upon the intervertebral foramina may occur from the vertebral bodies, the intervertebral disks, the articular processes, the articular capsule or joint areas themselves (Fig. 8).

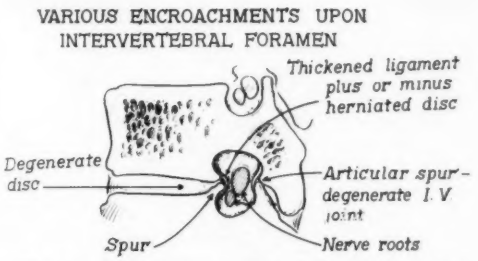


Fig. 8. The intervertebral foramen and areas from which possible encroachment may occur with significant impression upon the nerve root structures contained therein.

AN ANALYSIS OF THE FUNCTION OF THE LUMBAR SPINE AND ITS MEASUREMENT

Too often the spine is considered radiographically as a static organ, and too little study is made of its functional aspects. Actually, it is the functional aspect which is usually of greater significance, while the static structural deformities which may be noted are secondary. The cineradiographic medium offers a new approach to the study of function which is only now beginning to be developed. The spine can be studied, however, in static radiographs in various positions so that much information can be derived regarding spinal function. This may be accomplished by obtaining films in the lateral projection with the patient standing erect, in acute flexion,

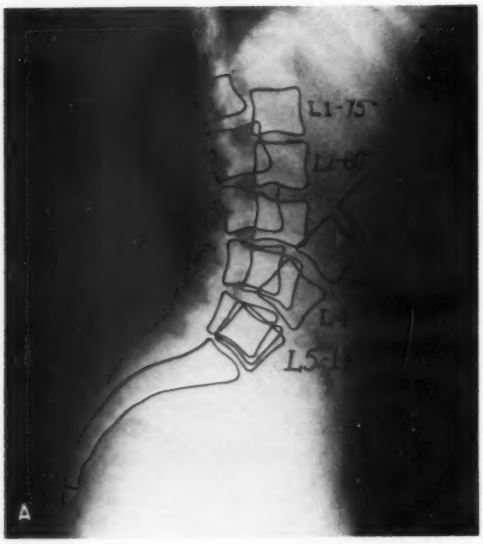


Fig. 9. Superimposed tracings of the lumbar spine in flexion and extension as well as neutral position. Relative movements of L-3, L-4, and L-5 give some indication of the presence or absence of disk abnormalities, since a relative immobility is noted under these circumstances.

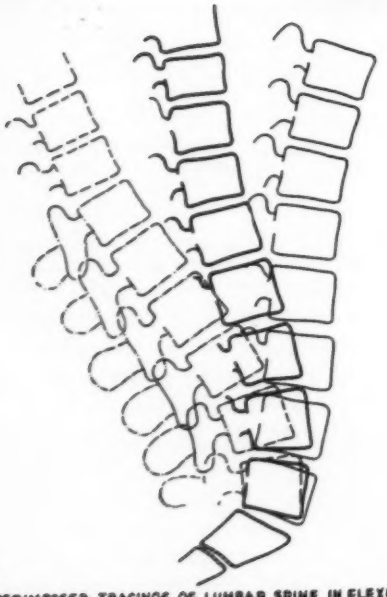
A. Radiograph.

B. Similar line tracing (5).

C. Relative movement of L-3, L-4, and L-5 may assist in localizing intraspinal disease. Studies with movement to one side or the other are obtained, and measurements of movement can indicate a slow gradation of movement from one vertebral body to the next under normal circumstances (5).

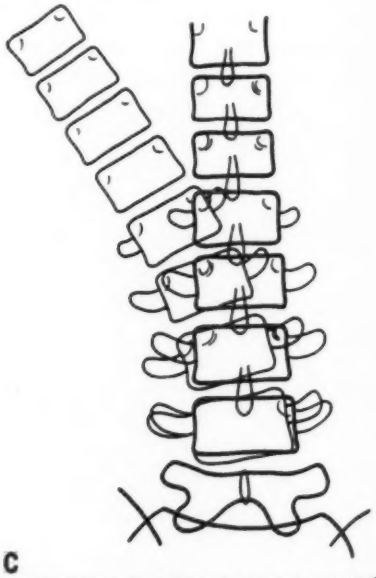
in relation to the intervertebral disks and that which occurs in the region of the intervertebral synovial joints.

The relationships of the vertebral bodies to the intervertebral disks in motion may be studied by drawing a line along the posterior margins of the vertebral bodies in the lateral projection in the various posi-



B

SUPERIMPOSED TRACINGS OF LUMBAR SPINE IN FLEXION AND EXTENSION AS WELL AS NEUTRAL POSITION. RELATIVE MOVEMENTS OF L3, L4, AND L5 GIVE SOME INDICATION OF PRESENCE OR ABSENCE OF DISC ABNORMALITIES, SINCE A RELATIVE IMMOBILITY IS NOTED UNDER THESE CIRCUMSTANCES.



C

RELATIVE MOVEMENT OF L3, L4, and L5 MAY ASSIST IN LOCALIZING INTRASPINAL DISEASE. NORMAL RELATIONSHIPS ARE SHOWN ABOVE. IMMOBILITY MAY ASSIST IN LOCALIZING DISEASE.

and in hyperextension (2) (Fig. 9, A and B). Likewise, in the anteroposterior projection, films may be obtained with the patient bending first to the left and then to the right (Fig. 9, C). Two areas of motion are studied: the motion which occurs

tions of the spine (3). When this is done, a gradation of movement in respect to each vertebral body is found, so that if there be an area of relative fixation this becomes of pathologic significance (Fig. 9, B). The angle of movement of one vertebral body

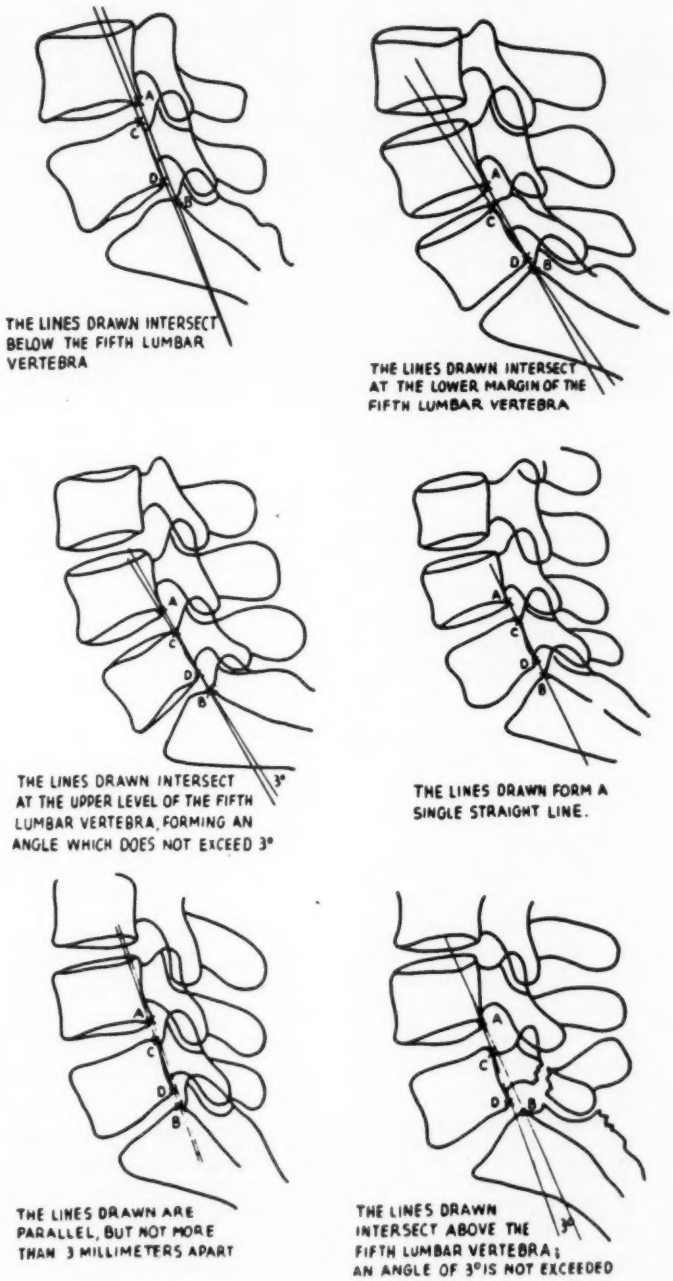
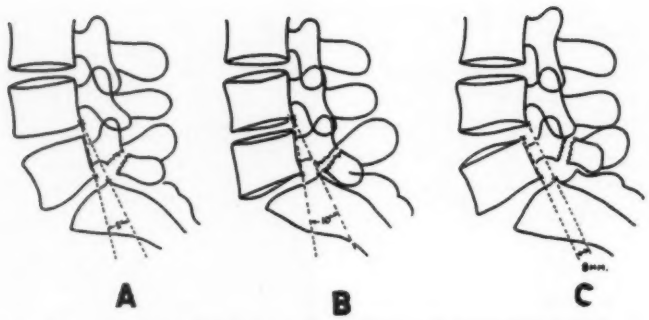
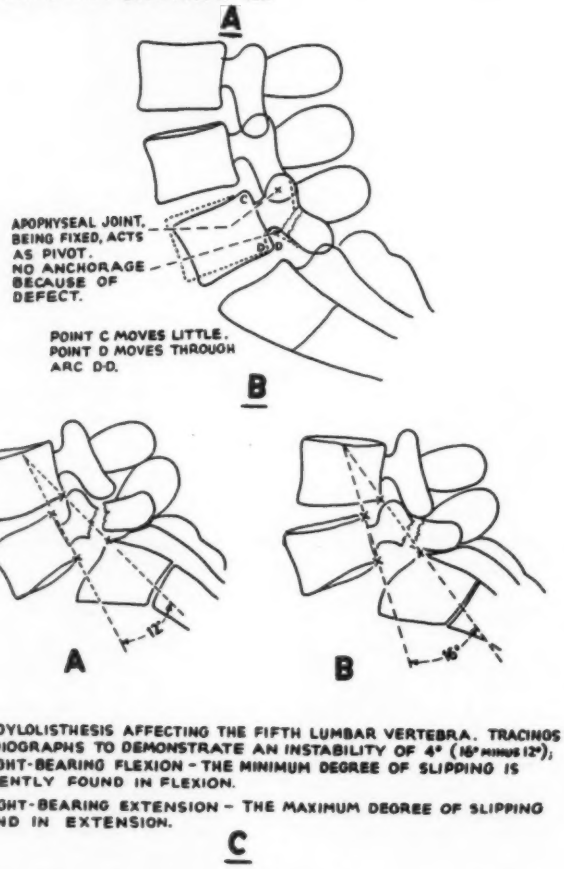

A
C
D
B
THE LINES DRAWN INTERSECT BELOW THE FIFTH LUMBAR VERTEBRA
THE LINES DRAWN INTERSECT AT THE LOWER MARGIN OF THE FIFTH LUMBAR VERTEBRA
THE LINES DRAWN INTERSECT AT THE UPPER LEVEL OF THE FIFTH LUMBAR VERTEBRA, FORMING AN ANGLE WHICH DOES NOT EXCEED 3°
3°
THE LINES DRAWN FORM A SINGLE STRAIGHT LINE.
THE LINES DRAWN ARE PARALLEL, BUT NOT MORE THAN 3 MILLIMETERS APART
THE LINES DRAWN INTERSECT ABOVE THE FIFTH LUMBAR VERTEBRA; AN ANGLE OF 3° IS NOT EXCEEDED
3°

Fig. 10. Method of alignment of L-4 and L-5, in a search for spondylolisthesis: lines A-B and C-D are drawn and configurations obtained normally as shown above (2).



TRACINGS OF RADIOGRAPHS OF SUBJECTS WITH SPONDYLOLISTHESIS. THE LINES EITHER INTERSECT ABOVE THE FIFTH LUMBAR VERTEBRA AND FORM AN ANGLE EXCEEDING 2° (A and B) OR REMAIN PARALLEL, BUT ARE MORE THAN 3 MM. APART (C).



SPONDYLOLISTHESIS AFFECTING THE FIFTH LUMBAR VERTEBRA. TRACINGS OF RADIOGRAPHS TO DEMONSTRATE AN INSTABILITY OF 4° (16° MINUS 12°); (A) WEIGHT-BEARING FLEXION - THE MINIMUM DEGREE OF SLIPPING IS FREQUENTLY FOUND IN FLEXION.

(B) WEIGHT-BEARING EXTENSION - THE MAXIMUM DEGREE OF SLIPPING IS FOUND IN EXTENSION.

Fig. 11. Method of alignment same as in Fig. 10. In this illustration, however, one may demonstrate the various abnormal appearances of such alignment in the presence of spondylolisthesis. The reason for this abnormal appearance is shown in part B. The apophyseal joint, being fixed, acts as a pivot and on this pivot the vertebral body swings forward because there is no anchorage inferiorly. This, therefore, swings the vertebral body usually in the arc of a circle, which is best measured by the angle shown (2).

with respect to the one immediately adjoining can be measured with considerable accuracy, and it is these angles which can be plotted, showing this gradation.

A slight variation of this method of alignment will allow one to detect slipping of a vertebral body forward with respect to adjoining vertebral bodies. This method is particularly useful in relation to spondylolisthesis. When a line is drawn along the posterior aspect of either L-4 or L-5 (Fig. 10), and is studied in relationship to the posterior margins of the vertebral bodies above and below this level, definite relationships are noted in the normal and abnormal. In a study of 1,000 normal spines, the normal relationships fell into the categories shown in Figure 10, with only 3 exceptions. Whenever slipping of a vertebral body occurs, as in the case of spondylolisthesis, the arrangement of the lines once again falls into definite categories, as shown in Figure 11. It will be noted that in this latter instance an angle is formed with the apex above the vertebral body in question, measuring more than 3°, or, if the lines remain parallel, the distance between them exceeds 3 mm. This method of alignment also offers an opportunity to detect changes in relationships of vertebral bodies with respect to one another with changes in the position of the patient under stresses and strains.

Occasionally one notices, in studying alignments in this manner, that the posterior border of a vertebral body appears to be displaced posteriorly with respect to the vertebrae above and below it. This has been referred to by some as "posterior or reverse spondylolisthesis." As pointed out by Melamed (4), occasionally the displacement is merely an apparent one, due to faulty projection of the spine, rather than a true anatomical variation. In study of a large number of specimens, however, he noted that there are several causes which may produce a true backward displacement: (*a*) degenerative processes in intervertebral disks; (*b*) disease processes particularly affecting intervertebral disks and the adjoining bone, such as tuberculosis,

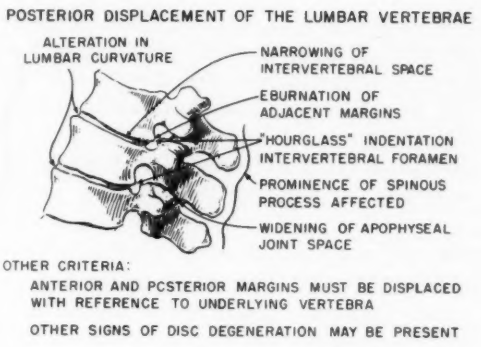

POSTERIOR DISPLACEMENT OF THE LUMBAR VERTEBRAE
ALTERATION IN LUMBAR CURVATURE
NARROWING OF INTERVERTEBRAL SPACE
EBURNATION OF ADJACENT MARGINS
"HOURGLASS" INDENTATION INTERVERTEBRAL FORAMEN
PROMINENCE OF SPINOUS PROCESS AFFECTED
WIDENING OF APOPHYSEAL JOINT SPACE
OTHER CRITERIA:
ANTERIOR AND POSTERIOR MARGINS MUST BE DISPLACED WITH REFERENCE TO UNDERLYING VERTEBRA
OTHER SIGNS OF DISC DEGENERATION MAY BE PRESENT

Fig. 12. Signs of posterior (or reverse) displacement of the lumbar vertebrae. After Melamed and Ansfield (4).

syphilis, and primary or secondary bone tumors; (*c*) trauma; (*d*) congenital anomalies. The criteria for recognition of true backward displacement on these bases are summarized in Figure 12. For example, one may see a narrowing of the intervertebral space with or without reactive changes at the margins of the adjoining end plates; evidence of calcification of the intervertebral cartilage; degenerative changes in the intervertebral disk *per se*, which may allow for stretching of a vertebral body; or posterior displacement of the spinous process of the affected vertebral body on the lateral projection. These roentgen signs of true backward displacement cannot be eliminated by any technical means.

The gliding movements of the apophyseal joints are probably best studied on lateral views of the cervical spine and on oblique radiographs of the lumbar spine. Here it can be demonstrated that normally there is a considerable fixation of one articular process with respect to its mate. If there be abnormal gliding movement, this can ordinarily be detected by a relative malalignment of the articular processes with respect to one another. Needless to say, these joints are subject to all of the diseases which affect synovial joints, including the rheumatoid as well as the hypertrophic arthritides. For demonstration of the effects on these joints, the best views are those obtained in various degrees of obliquity. One can hardly anticipate the exact

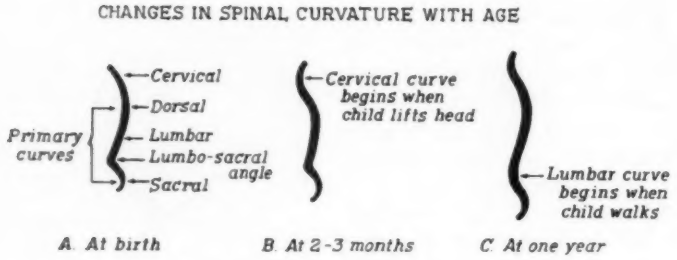


Fig. 13. Changes in spinal curvature with age.

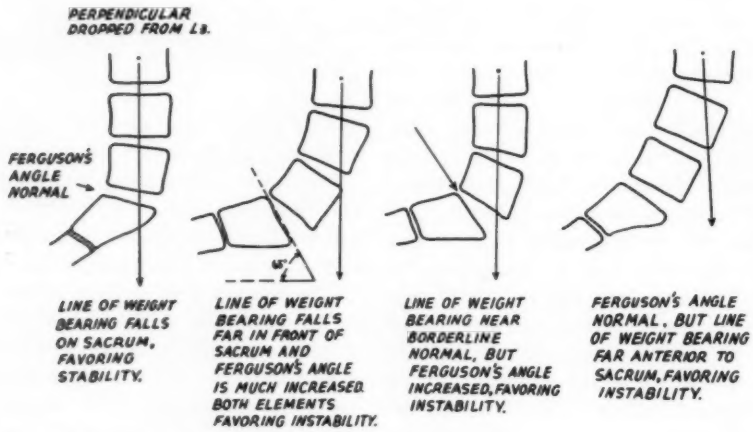

PERPENDICULAR DROPPED FROM Lb.
FERGUSON'S ANGLE NORMAL
LINE OF WEIGHT BEARING FALLS ON SACRUM, FAVORING STABILITY.
LINE OF WEIGHT BEARING FALLS FAR IN FRONT OF SACRUM AND FERGUSON'S ANGLE IS MUCH INCREASED. BOTH ELEMENTS FAVORING INSTABILITY.
LINE OF WEIGHT BEARING NEAR BORDERLINE NORMAL, BUT FERGUSON'S ANGLE INCREASED, FAVORING INSTABILITY.
FERGUSON'S ANGLE NORMAL, BUT LINE OF WEIGHT BEARING FAR ANTERIOR TO SACRUM, FAVORING INSTABILITY.

Fig. 14. Method of studying the line of weight-bearing with respect to the sacral and pelvic support (5).

angle of obliquity in any given instance, and it is only by obtaining two or three films in a given patient that a proper analysis can be made.

SEQUENCE OF CHANGES IN THE LINE OF WEIGHT-BEARING

At birth the vertebral column has only two curves with a figure-3 configuration (Fig. 13). It is a very asymmetrical 3 because the central angle is at the junction of the last lumbar and the first sacral segment, the so-called sacral-vertebral or lumbosacral angle. The cervical curvature begins to be formed two or three months after birth, when the child begins to lift its head significantly, and becomes further developed when he begins to sit upright, at seven to nine months of age. The lumbar curvature first appears at about one year of age, when walking is begun. The thoracic and sacral curves are the true primary curves of the spine. With advancing years the column loses its flexibility and resilience, and variable amounts of calcification occur at the junction of the vertebral bodies with the paraspinous ligaments. Apart from the system of alignment already described, which in some respects is related to the line of weight-bearing, there are three other alignment systems which are worthy of mention in relation to weight-bearing:

1. In the lateral view of the lower dorsal segments as well as the lumbar spine, the line of weight-bearing can be found by bisecting the major portion of the lower dorsal vertebral bodies and upper lumbar segments (Fig. 14). It should fall directly over the superior margin of the sacrum.

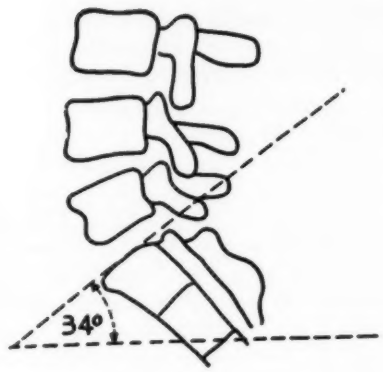


Fig. 15. Author's modification of Ferguson's normal lumbosacral angle. It is noted, however, that both the line of weight-bearing and the lumbosacral angle must be compared because it is conceivable that the line of weight-bearing may favor instability and still a normal lumbosacral angle may be obtained (5).

superior margin of the sacrum. This normal angle should not exceed 34°. An excess over this figure, particularly if it is associated with an abnormality in the line of weight-bearing, may be interpreted as indicative of some measure of instability. Some orthopedists discount the value of this alignment technic.

3. Various methods have been devised for measurement of scoliosis and for determination of primary and secondary curvatures of the spine. The simplest method is that illustrated in Figure 16 (6), in which the patient bends first in one direction and then in the other. If the curvature remains constant, one is dealing with a primary curvature. If the curvature tends to correct itself, then it is a secondary type.

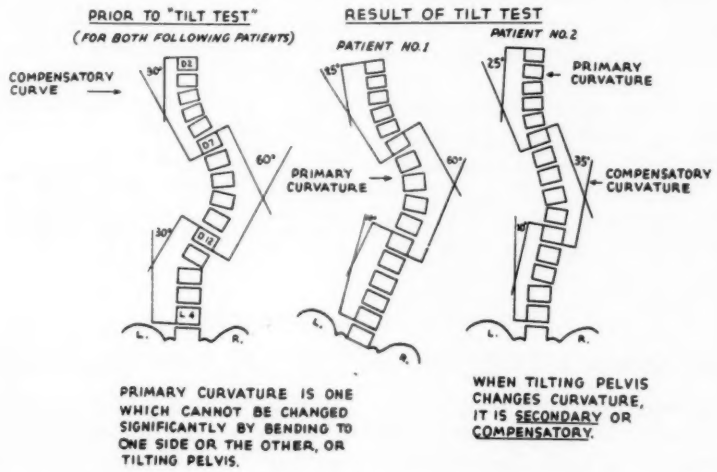


Fig. 16. Method of measurement and determination of primary and secondary curvature in scoliosis. After Ferguson (6).

If it falls either anteriorly or posteriorly to the sacral promontory, then one can presume that a state of instability exists (5).

2. Ferguson's angle (6) or the lumbosacral angle, may be of some assistance in the evaluation of lumbosacral instability, although this *must always be interpreted in relation to the line of weight-bearing*, as illustrated in the accompanying figure (Fig. 15). We have modified the method of obtaining Ferguson's angle by determining the relationship of the horizontal with the One can readily measure the extent of the curvature for all applications, as is shown in the figure.

4. The alignment of one vertebral body with respect to its adjoining vertebral bodies has already been described. This method is useful in determining local areas of spasm or immobility, as in association with herniated disks. This method is also useful in detecting and measuring degrees of spondylolisthesis and determining stability of a slipped vertebral body.

SUMMARY

The development of the lumbosacral spine has been traced in relation to its membranous, cartilaginous, and ossific stages, and various aberrations of the normal have been described. Appearances in relation to defective ossification have been shown not only in relation to the vertebral body proper, but also with regard to the neural arch.

The study of the functioning spine has been stressed in relation to various systems of alignment which have been adapted to this purpose. These systems emphasize the relationship of weight-bearing to a state of instability at the lumbosacral junction. Alignment systems have also been developed for detection of spondylolisthesis and instability in relation to slipped vertebral bodies. The concept of posterior spondylolisthesis has also been discussed.

In a study of the normal lumbosacral spine one must constantly be cognizant of the importance of the synovial intervertebral joints. They are subject not only to all of the diseases from which other diarthrodial joints suffer, but especially they may give rise to projections or encroachments upon the intervertebral foramina and the nerve structures contained therein.

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SUMMARIO IN INTERLINGUA

Importante Aspectos In Le Studio Roentgenologic Del Normal Spina Lumbosacral

Embryologicamente le columna vertebral se disveloppa in tres stadios: Le stadio membranose, le stadio cartilaginose, e le stadio ossific. Varie aberrationes disveloppamental occurre durante iste stadios, sed illos non es necessarimente de signification pathologic.

Variationes in le plano del articulationes intervertebral synovial, specialmente inter L-5 e S-1, es probabilemente relationate a certe casos de instabilitate del junction lumbosacral e de dolores infero-dorsal. Le corpores vertebral, le discos intervertebral, le processos articular, e le capsulas articular e le areas del articulation mesme pote interferer con le foramines intervertebral e comprimer le structuras nerval que es continite in illos.

Le importantia del studio functional del spina dorsal es sublineate. Duo areas de motion es considerate: Illo relationate al functiones del discos intervertebral e illo del articulationes synovial intervertebral. Es describite un systema de alineation que indica le relation del corpores vertebral al discos intervertebral in motion. Un leve modification de iste methodo permitte le detection del displaciamento de corpores vertebral e es specialmente utile in le diagnose de spondylolisthesis. Anormalitates in le movimentos glissante del articulationes apophysee pote ordinarimente esser detegite per le constatation de un relative misalineation del processos articular.

Es etiam discutite studios de systemas de alineation in relation al portar de peso.

An Etiologic Study of Back Pain[1]

RALPH K. GHORMLEY, M.D.

SOME YEARS AGO my colleagues and I undertook a study of the etiologic aspects of pain in the lower part of the back and of sciatica. We had intended to study the factors concerned among all patients at the Mayo Clinic presenting this as one of their major complaints during a period of a year. The material became so great, however, and the figures so involved, that we were forced to limit our study to 2,000 patients. This was approximately 40 per cent of the patients seen in the course of one year.

We have already published the tabulation of the results of our studies (1, 2). That these figures do not represent a cross section of the population is obvious, for the patients concerned were those who came to the Mayo Clinic for counsel about various complaints. Many had received treatment for pain in the lower part of the back or for sciatic pain, and correct diagnoses had been made before they entered the Clinic.

TABLE I: DISTRIBUTION OF 2,000 CASES OF BACKACHE ACCORDING TO CAUSE

Cause	Number	Per Cent of 2,000 Cases	Sciatic Pain, Cases
Osteoarthritis	511	25.6	44
Protruded disk suspected	445	22.3	324
Indeterminate causes	384	19.2	24
Static disturbances present	160	8.0	3
Rheumatoid spondylitis	131	6.5	5
Coccygodynia	55	2.7	1
Previous trauma (old fracture, usually)	52	2.6	3
Spondylolisthesis	44	2.2	9
Tuberculous spondylitis	38	1.9	2
Osteoporosis	36	1.8	1
Recent trauma other than fractures	31	1.6	0
Recent fractures	25	1.3	1
Spondylolysis	13	0.7	2
Scoliosis	11	0.6	0
Metastatic neoplasms of vertebrae	11	0.6	1
Fibrositis	8	0.4	0
Previous fusion operation	7	0.3	1
Primary neoplasms of cord and soft tissues adjacent to vertebrae	5	0.2	2
Gynecologic disease	5	0.2	1
Infectious spondylitis or osteomyelitis (nontuberculous)	5	0.2	1
Previous operation for protruded disk, with or without fusion	4	0.2	2
Facet syndrome	4	0.2	0
Primary neoplasms of vertebrae	3	0.1	0
Vertebral epiphysitis	3	0.1	0
Paget's disease	3	0.1	2
Interspinous ligament syndrome	2	0.1	1
Sacralization, partial	2	0.1	0
Metastatic neoplasms of cord and adjacent soft tissues	1	0.1	1
Compensation neurosis	1	0.1	0

OSTEOARTHRITIS

In the largest group of cases the causative condition was diagnosed as osteoarthritis (Table I). This admittedly is a poor diagnosis, for in most of these cases there is no real arthritis. The hypertrophic or degenerative changes which are noted often arise as a result of wear and tear, hard usage, and injury. Patients with this condition frequently are free of symptoms as long as they do not indulge in hard work or other forms of activity which may cause local irritation around the vertebrae and thus incite pain. Many in this group had symptoms suggesting fibrositis; some had other conditions, such as disease of the genitourinary tract, which might have contributed to their symptoms.

SUSPECTED PROTRUDED INTERVERTEBRAL DISK

Many patients are sent to the Mayo Clinic with a diagnosis of protruded intervertebral disk. It is to be expected, therefore, that in a large proportion of our cases the pain would be attributed to that condition. This number, 445, represented

[1] From the Section of Orthopedic Surgery, Mayo Clinic and Mayo Foundation, Rochester, Minn. The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

Presented, as part of a Symposium on The Lumbosacral Spine, at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

about 22 per cent of the entire series. Of these 445 patients, 161, or 36 per cent of those suspected of having a protruded intervertebral disk, were operated upon. In 121 cases a protruded disk was removed without performance of fusion, whereas in 26 cases a protruded disk was removed and fusion was performed. Among 14 cases in which a protruded disk was not found at operation, fusion was performed in 8. The remainder of the patients were treated conservatively. A few were advised to undergo operation, but refused. A total of 324 of the patients suspected of having a protruded intervertebral disk, or approximately 73 per cent, also had sciatic pain at the time of examination.

INDETERMINATE CAUSES

In a group of 384 cases, or about 19 per cent, the back pain was of a mixed type, the exact nature of which it was difficult to determine. In some instances a "fibrositic" type of pain predominated, and doubtless fibrositis or myositis was present in many cases. In many, the backache was of a postural type, best called "chronic postural strain." A fairly large group of patients were thought to have chronic sacroiliac strain or nonrheumatoid sacroiliac disease. Formerly such a diagnosis was often made, but as recognition of the syndrome of protruded intervertebral disk increased, it lost favor. The diagnosis of chronic sacroiliac strain or nonrheumatoid sacroiliac disease is always hard to prove, but I believe the condition does occur and should not be entirely forgotten.

STATIC DISTURBANCES

Backache which is brought on by activity and is relieved by rest represented 8 per cent of our group of 2,000 patients. Usually, some mechanical fault is present, although it may not be demonstrated roentgenographically. "Chronic strain" which represents some degree of ligamentous damage, often accompanied by poor musculature, accounted for a part of this group. Degeneration of intervertebral disks, with or without demonstrable thinning of the disks in the lumbar region, may be present. This condition, described by Friberg and Hirsch (3), undoubtedly is present in some cases. It can be demonstrated only by diskograms, entailing a procedure which in our hands has not proved to be of great value.

RHEUMATOID SPONDYLITIS

In 131 cases, or 6.5 per cent, the diagnosis of rheumatoid spondylitis was made. This is probably a high percentage in a study of the etiologic aspects of backache. However, a large number of patients with such a condition are seen at the Mayo Clinic, and the percentage understandably is increased because of this.

The importance of this particular group of cases cannot be overemphasized, for an incorrect diagnosis may be made easily in the early stages of this disease. The usual roentgenologic picture of haziness of the sacroiliac joints and marginal spurring or bridging between vertebrae often is a late manifestation. When the foregoing features are present, the diagnosis may be obvious from the roentgenogram, but in our opinion the clinical symptoms and signs are important. A history of pain and stiffness in the morning, obvious limitation of motion of the spinal column, and limitation of chest expansion all are important points in the diagnostic picture. Polley and Slocumb (4), in a study of 1,035 cases of rheumatoid spondylitis, found that sciatic pain was the first manifestation of the disease in about 10 per cent of the cases.

COCCYGODYNIA

There were 55 cases of coccygodynia in our series. These patients for the most part are psychoneurotic. Although they undoubtedly may have pain, positive evidence to explain its occurrence is rarely found. One may see distortion and angulation of the coccyx or evidences of hypertrophic changes about the sacrococcygeal joint in some cases, but in the main the roentgenologic findings are minimal or are of no particular significance.

PREVIOUS TRAUMA

There was a relatively small group of 52 patients, or 2.6 per cent of the total, from whom a history of antecedent trauma was elicited. In most instances an old fracture, either overlooked or inadequately treated, was found to be present. Recent trauma other than fracture was present in 31 patients, and in 25 cases fractures were definitely demonstrable on roentgenograms, although in the group who had sustained trauma recently, roentgenologic procedures offered little help.

SPONDYLOLISTHESIS AND SPONDYLOLYSIS

Spondylolisthesis was found in 44 cases and spondylolysis in 13. The total of 57 cases constituted about 3 per cent of the series. These conditions are readily diagnosed by means of satisfactory roentgenograms. About 19 per cent, or 11 patients, of this group, had sciatic pain. It has been said that protruded intervertebral disks may be present in spondylolisthesis or spondylolysis. In none of the patients of this group who were operated upon was a protruded intervertebral disk found. We believe the complication occurs less frequently than is claimed by some.

TUBERCULOUS SPONDYLITIS

A diagnosis of tuberculosis of the spinal column was made in 38 cases (about 2 per cent) of the entire group. This condition is seen much less frequently now than in years past. It may, however, be easily missed, particularly when in the early stages, at a time when the roentgenologic changes are either minimal or absent. Thinning of an intervertebral disk, with fusiform soft parts and swelling surrounding the spinal column at the sites of involvement, should lead one to suspect tuberculosis. Today, needle or open biopsy often is necessary in order to establish this diagnois.

OSTEOPOROSIS

Postmenopausal or senile osteoporosis was found in 36 patients of this series. This particular condition usually is found in women past middle life, and the picture is fairly definite, meaning that osteoporosis, pathologic fractures of one or more vertebrae, and ballooning of intervertebral disks are seen. One should always bear in mind, however, that approximately the same roentgenologic picture may be seen in the presence of myeloma. Additional clinical studies will be necessary before the diagnosis can be certain. We have found that examination of a specimen of sternal bone marrow is of much help in such cases.

OTHER CONDITIONS

Scoliosis was noted in 11 cases. In the adolescent, scoliosis usually is painless, but in a relatively small group of adults who have had scoliosis for many years the degeneration and hypertrophic changes may be the bases of a painful syndrome.

Fibrositis alone was diagnosed in 8 cases. This figure, however, is misleading, because, as previously noted, many patients with disease of indeterminate cause probably had fibrositis, and many in the group with osteoarthritis undoubtedly had an accompanying fibrositis.

The observation of primary neoplasms of the spinal cord and soft tissues adjacent to the vertebrae, in 5 cases, emphasizes the fact that the possible presence of such lesions as a cause of backache never should be overlooked.

The small number of gynecologic patients who had back pain is misleading, because in most instances lesions of the pelvic organs are indexed as such, while backache as a symptom may or may not be indexed.

Infectious spondylitis or osteomyelitis of other than tuberculous origin was found in 5 cases. Again, recognition of this condition as a cause of back pain may be difficult in the early stages, but as the disease advances it is easily recognized, as a rule.

The relatively small number of congenital anomalies noted as causes of back pain similarly may be misleading. Such anomalies may have been present in the groups designated as osteoarthritis and indetermi-

nate, but they did not seem to be the predominant cause of pain. It is our belief, however, that many congenital anomalies are not the etiologic basis for the complaint of pain in the lower part of the back.

Breck, Hillsman, and Basom (5) reported that 31 per cent of 450 consecutive applicants for heavy work presented roentgenologic evidence of some type of congenital anomaly. All these persons denied that they ever had experienced back pain. Undoubtedly some types of congenital anomaly may predispose toward back pain, but certainly many anomalies are of no significance as primary causes of this symptom.

Increased lumbosacral angle was not listed in our study. This condition has for many years been given by various individuals as an explanation of pain in the lower part of the back. In our opinion, it may be a contributing factor in some cases, but it seems doubtful that it may in itself be the sole cause of such pain.

Likewise, thin intervertebral disks frequently may be regarded as a cause of pain in the lower part of the back. Undoubtedly, in numerous instances, they are to be found in patients who complain of such pain. We are sure, however, that many persons who present roentgenologic evidence of a thin lumbar intervertebral disk never experience back pain. One must distinguish between the thin lumbosacral disk which is caused by degenerative changes and the thin disk which is part of an anomaly. When the disk becomes thin as a result of degenerative changes there may be a history of periods of low back and sciatic pain. Thus, it is necessary to rely on the history and the physical signs, as well as on the roentgen findings, in reaching a conclusion as to the significance of this condition.

Friberg (6), in a study of degeneration of lumbar intervertebral disks and sciatica, wrote: "In the past few years when it has been possible to detect a disc disintegration at an earlier stage by the instability test, we have found disc disintegration in up to 50 per cent of all cases of low back pain. In many cases, the X-ray examination had been negative at the first visit to the clinic, but at later controls we were able to diagnose disintegration."

It is our opinion that damage to an intervertebral disk may occur, and frequently may cause transient attacks of back pain, with or without sciatic extension. Such damage, without actual protrusion of a disk or disks, may lead to subsequent roentgenologic changes. To say, on the basis of roentgen studies alone, that such a lesion is the cause of a patient's pain is in our opinion unjustifiable.

COMMENT

We have presented a résumé of the findings in 2,000 cases in which patients complained of pain in the lower part of the back or sciatic pain or both. Detailed roentgenologic studies are not presented; rather, the findings have been summarized, so that a single diagnostic entity becomes evident in most of the categories concerned.

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SUMMARIO IN INTERLINGUA

Un Studio Etiologic De Dolor Dorsal

Esseva effectuate un studio etiologic de dolores infero-dorsal super le base de 2.000 patientes vidite al Clinica Mayo in qui tal dolores esseva un del gravamines principal. In plus que 25 pro cento del casos (511), le dolores esseva attribute a osteoarthritis, sed il debe esser signalate que in le majoritate del casos de iste gruppo il non se tracta de un ver arthritis, viste que le alterationes resultava frequentemente de uso e abuso, de travalio pesante, e de injuria physic. In le secunde gruppo major de casos (445), le causa listate esseva protrusion (suspicite) de un disco. Dolor dorsal producite per activitate e alleviate per reposo esseva trovate in 160 casos e esseva considerate generalmente como causate per le un o le altere vitio mechanic. Spondylitis rheumatic esseva considerate como responsabile pro le dolores in 131 patientes. Un extense varietate de altere causas es listate, cata un como representante de inter 55 casos e un sol. In 384 casos, le dolores esseva de typo mixte e lor exacte natura remaneva indeterminate.

Detaliate studios roentgenologic non es presentate, sed le constatationes es summarisate de maniera que un unic entitate diagnostic deveni evidente in le majoritate del categorias.

Consideration of Pre-Existing Conditions, Congenital and Acquired, in the Preplacement Spine Examination

WAYNE A. SIMRIL, M.D.

AS ONE MIGHT suspect from the title, this paper will be primarily concerned with the accurate identification of congenital and acquired abnormalities of the spine and their significance to the worker, the industrial physician, and the personnel director. If a physician—and this means radiologist, orthopedist, or industrial surgeon—is to be responsible for accepting, rejecting, or placing applicant workers in industry, it behooves him to be cognizant of the many factors to be considered in radiographic examination of the spine.

Perhaps I should say, at the outset, that I do not plan to refer to multiple contributions on this subject but to present my own opinions bolstered by discussion with orthopedic surgeon colleagues. When I first began this paper, I looked through the literature; now I think I can safely say that there is a wide range of opinion on the significance of most of the abnormalities and anomalies to be discussed here.

Abnormalities which will be discovered in an adequate pre-employment roentgen study of the lumbar spine—*i.e.*, anterioposterior, lateral, and both posterior oblique views—fall into three major groups. They are: (*a*) conditions secondary to disease either acute or degenerative; (*b*) conditions secondary to trauma; (*c*) congenital anomalies. Their differentiation and the determination of their functional significance are often mishandled. Thus most of the discussion will be in this area.

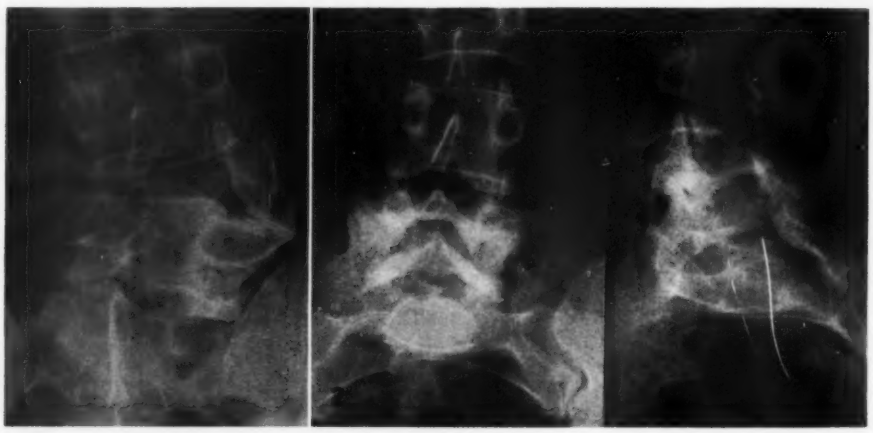

Fig. 1. Hemivertebrae such as this between the fourth and fifth lumbar vertebrae give rise to instability and secondary degenerative changes by altering the normal weight-bearing column.
Fig. 2. A congenital tilt of the fifth lumbar body causes much the same changes as a hemivertebra. Note degenerative eburnation of apophyseal facets.

Hemivertebrae (Fig. 1), congenital scoliosis secondary to a tilt of the fifth lumbar vertebra (Fig. 2), neural arch defects with spondyloschisis (Fig. 3) or spondylolisthesis (Fig. 4), and unilateral sacralization or lumbarization (Fig. 5) are considered to be of major importance. Often the cause of pain and instability, these abnormalities are not compatible with good function in a man expected to do heavy labor.

[1] From the Department of Radiology, Washington University School of Medicine, St. Louis, Mo. Presented as part of a Symposium on the Lumbosacral Spine at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

Accessory ossicles (Figs. 6 and 7), unfused epiphyses (Fig. 8), spina bifida occulta (Fig. 9), sacral hiatus canalis (Fig. 10), complete or partial failure of segmentation in the mid or upper spine (Fig. 11), bilateral sacralization (Fig. 12), ossified ligaments (Fig. 13), absence or abnormalities of the spinous and transverse processes and "kissing" spinous processes (Fig. 14) are not of clinical significance. One is not justified in denying employment of any sort on the basis of discovery of one or more of these, if unaccompanied by physical signs. Variations in degree of lordosis or angulation at the lumbosacral junction are equally unimportant unless based on an actual abnormality such as soft-tissue contracture in the low back.

Healed or asymptomatic fractures of spinous and transverse processes (Fig. 15) are relatively unimportant. Healed fractures of apophyseal facets or vertebral bodies (Fig. 16) are more apt to be associated with damage to intervertebral disks and with instability. A thorough clinical evaluation is, of course, necessary. The pre-employment examination is of value in this area, too, because it puts on record the existence of prior injury.

Congenital anomalies most apt to be confused with traumatic changes are unfused epiphyses and accessory ossicles. Another

Fig. 3. This spine was clinically unstable and symptomatic. Unilateral or bilateral spondyloschisis with or without forward slipping is often associated with a narrow lumbosacral disk. A defect on the "normal" side can sometimes be demonstrated by films in different degrees of obliquity, but not in this case.

Fig. 4. Typical bilateral neural arch defects accompanied by minimal spondylolisthesis. The multiple fragments on the right are not uncommon. Again the lumbosacral disk is narrowed.

Fig. 5. Unilateral sacralization, such as is shown here, puts a good deal of rotational stress on the disks and vertebrae above. Note, too, the degeneration of the apophyseal joints on the left.

Fig. 6. This illustration of a unilateral accessory facet demonstrates well the larger total size of the anomalous side, which is always present in these cases but not in fractures.

Fig. 7. Advanced degeneration of disks and apophyseal joints allows spondylolisthesis to occur without neural arch defects. Note bilateral accessory ossicles.

Fig. 8. This illustration demonstrates unfused superior cortical epiphyses often confused with fractures. The second lumbar vertebra is the site of healed osteochondrosis (Scheuermann's disease) also often misinterpreted.

Fig. 9. Spina bifida occulta of this type is of no significance and can safely be disregarded in consideration of work assignments. (Photo retouched.)

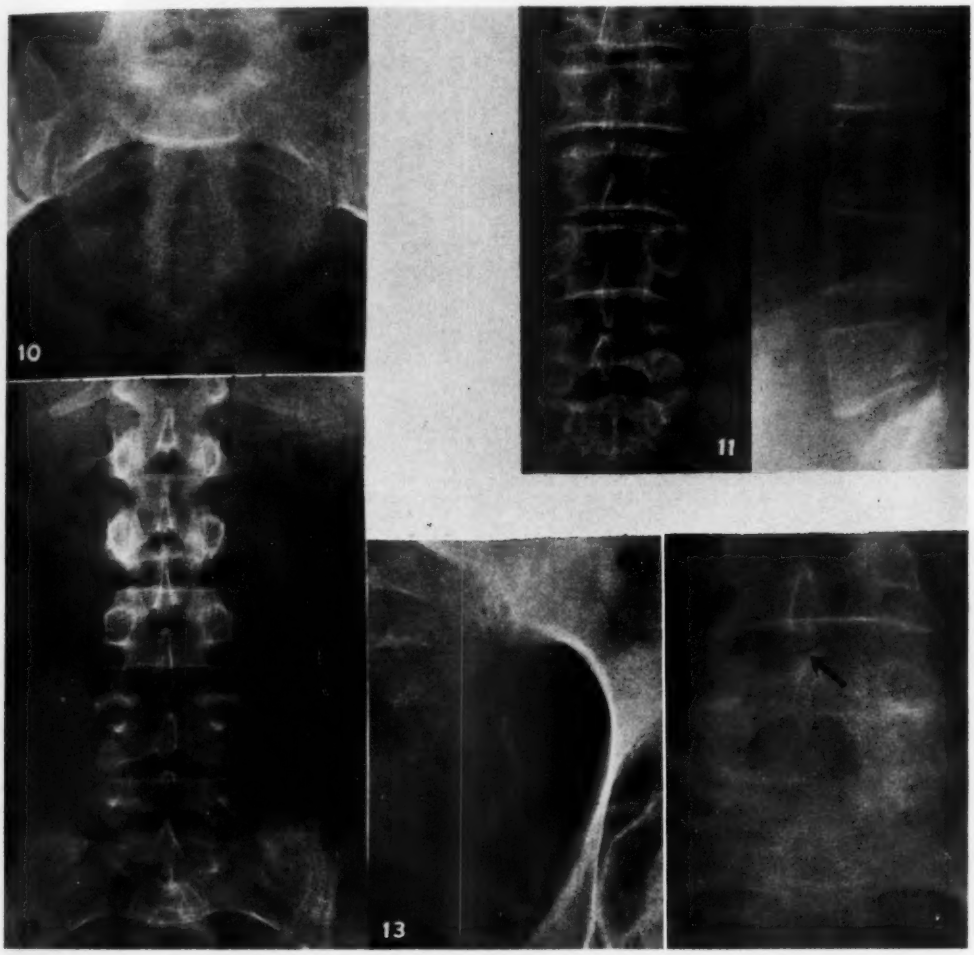

Fig. 10. Sacral hiatus canalis, a developmental variation of no clinical significance.
Fig. 11. Partial failure of segmentation and calcification of poorly formed disk. Hypertrophic spurs are also present, indicative of degeneration and probably old trauma.
Fig. 12. Complete bilateral sacralization of the fifth lumbar vertebrae. In these cases no additional strain is placed on the vertebrae above.
Fig. 13. Ossification of sacrospinous ligament. In the absence of physical signs, this is probably of no significance.
Fig. 14. "Kissing" spinous processes.

developmental abnormality often mistakenly considered acutely traumatic is spondylolisthesis. Perhaps even more commonly reported as traumatic is the wedged vertebra of healed Scheuermann's disease (Figs. 17 and 18), which I have several times heard described as a compression fracture during legal proceedings by solemn but inexperienced "experts."

Even more important to the worker than to the employer is the recognition of acute or chronic disease which may well have gone unrecognized. Retroperitoneal masses or hemorrhage, metastatic disease (Fig. 19), infections, aneurysms (Fig. 20), or even such rare conditions as diastematomyelia (Fig. 21) may well be "picked-up" on routine pre-employment examinations.

To sum up, I think it is fair to say that an adequate pre-employment spine examination is of great value to both worker and

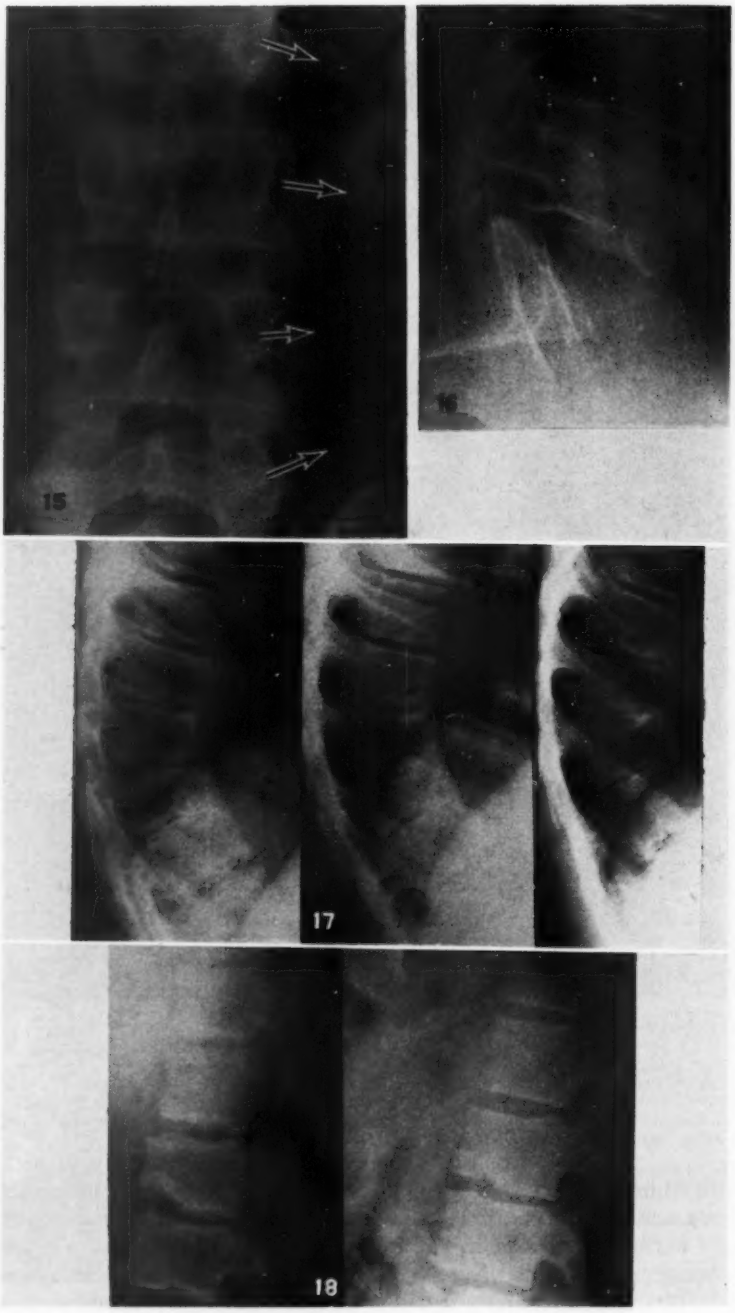

Fig. 15. Multiple healed and ununited fractures of transverse processes. Recognition and a record of these are of value in future possible injuries and litigation.

Fig. 16. A typical healed "double-surface" compression fracture. An injury of this magnitude nearly always damages the adjacent disks as well.

Fig. 17. Extensive osteochondrosis with eventual fusion—a rare sequel. This condition should not be mistaken for fracture.

Fig. 18. Osteochondrosis of the upper lumbar spine with a more typical end deformity.

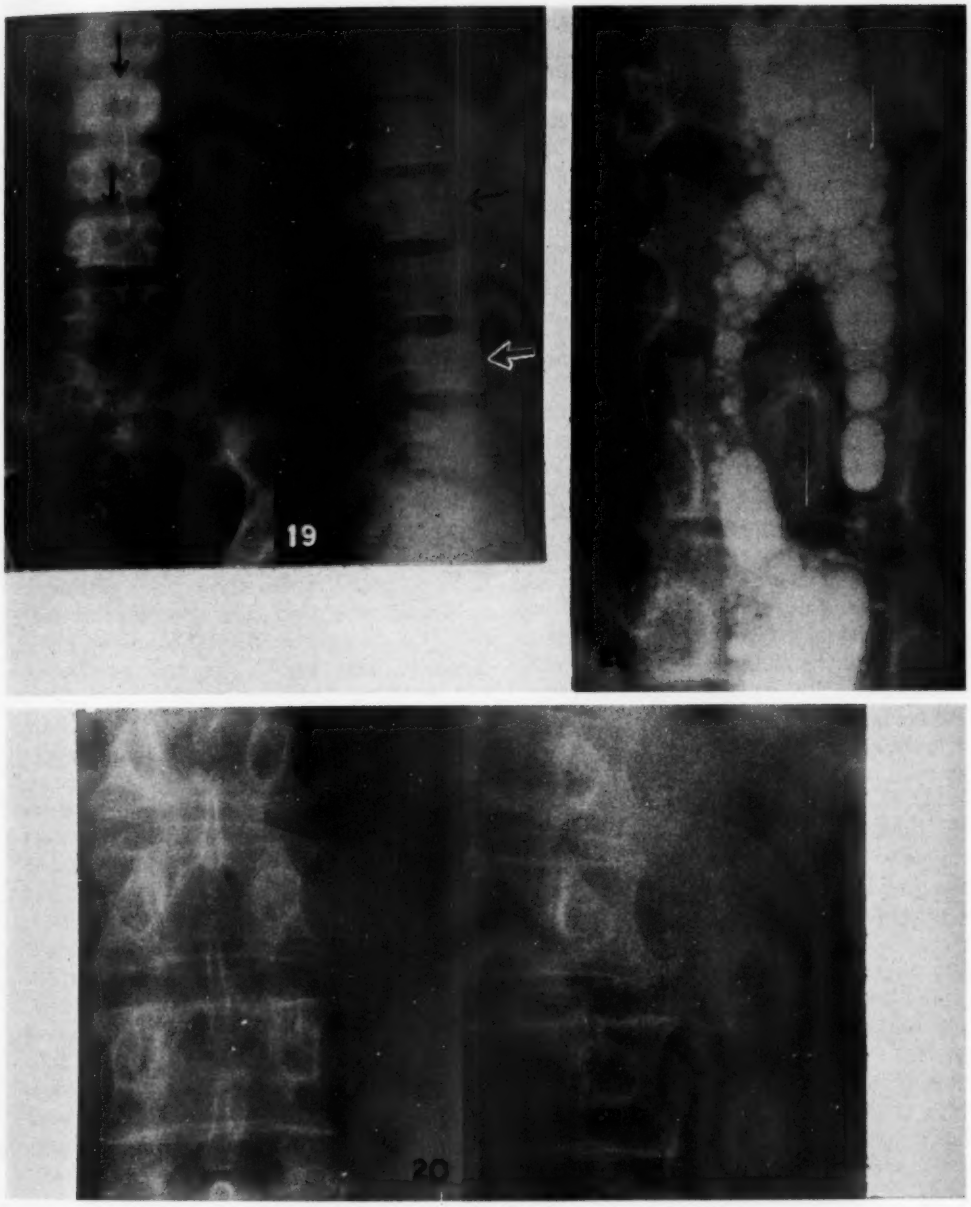

Fig. 19. Metastatic Hodgkins "ivory" vertebrae.
Fig. 20. Saccular aneurysm of the abdominal aorta, discovered in routine examination.
Fig. 21. Myelogram in a case of diastematomyelia. The central bony spicule was clearly visible in routine films.

employer. This is particularly true when it is accompanied by a good history and physical examination and occupies a place in an enlightened personnel placement program.

I should also add a plea for impartiality on the part of the examiner. We must not identify ourselves with either worker or employer but remain absolutely impartial in order to be of real service to both.

SUMMARIO IN INTERLINGUA

Consideration De Conditiones Pre-Existente, Congenite E Acquirite, In Examines Del Spina Dorsal Ante Le Placiamento Del Mano De Obra

Un adequate examine roentgenologic del spina dorsal ante le placiamento del mano de obra es de valor tanto pro le empleator como etiam pro le empleato, specialmente si illo es accompaniate de un bon historia e exacte examine physic. Le anormalitates que es assi discoperite pote esser gruppate in tres categorias: Conditiones secundari a morbos, conditiones secundari a trauma, e conditiones congenite. Certes inter iste conditiones non es compatibile con le efficace functionamento de un homine ab qui on expecta labores pesante. Alteres es relativemente inimportante e non pote esser considerate como un ration sufficiente pro rejicer le applicante.

Value of Preplacement Examination of the Lumbar Spine[1]

ROBERT D. MORETON, M.D., JOHN R. WINSTON, M.D., and DOUGLAS E. BIBBY, M.D.

THERE IS NO SINGLE condition where skilled labor is involved that causes more loss of man-hours than low back symptoms (Runge). Coulter found that 79 per cent of back strains were in the lumbosacral area, as compared with only one-third of fractures. He believes that the lumbosacral spine is especially vulnerable to injury for two reasons: first, it is least protected by supporting structures in the region; second, it is more often subjected to excessive strain in lifting and bending than are other sections of the vertebral column. To be considered also is the fact that the lumbosacral region is more frequently the site of anomalies than any other part of the body. Colcher and Hursch point out that pain and disability could be and often are consistent with the anomalous findings. For these reasons, preplacement roentgen examinations of the lumbosacral spine have passed the stage of innovation. Cushway and Maier reported on routine examination of the spine for industrial employees in March of 1929. In their series of 931 examinations, 414 men were found to have a total of 510 anomalies and abnormalities.

The necessity for preplacement examinations has been further emphasized by the steady increase in the number of so-called "industrial backs" in the recent past. Becker reported that from 1940 to 1950 Ohio had an increase of 31 per cent in employment and that during that period there was a 132 per cent increase in back injuries. In the same decade, with an increase of only 7 per cent in the industrial force of New York, back injuries increased 43 per cent. Becker also cites the experience of Minnesota, with a 57 per cent increase in its industrial force and 80 per cent increase in back injuries. The monetary significance of these observations is illustrated by a year's experience in the Commonwealth of Pennsylvania, with over 6,900 back injuries reported and nearly $1,500,000 in related compensation payments. According to Carney, these conditions cost the American railroads 29 million dollars in claims in 1941. In 1951 and each year thereafter, over 100 million dollars have been paid out, even though accidents were reduced.

Any traumatic cause of backache, superimposed upon a pre-existing low back affection, causes a difficult medical problem, from the point of view of both patient and physician. The greatest difficulty is the estimation of the actual significance of the patient's complaints as compared with the physical signs of injury and its effect on the pre-existing low back condition. As Flaxman has pointed out, many patients with low back affections work and carry on a normal life until trauma aggravates a pre-existing lesion. It may be that the complaint of backache is so common that hardly anyone gives it much attention until an injury aggravates the pain. The focusing of a pre-existing lesion in its location by some type of trauma firmly fixes the presence of the back disability in the patient's mind.

Our program of preplacement roentgen examination of the lumbosacral spine is carried out in an attempt to ascertain these pre-existing conditions and place the prospective employee in a job which, it is felt, he can adequately handle without undue danger to himself or the public. Similar examinations have been reported by Breck, Hillsman, and Basom, Bohart, Barton and Biram, Coulter, Colcher and Hursch, and Stewart, with the percentage of abnormalities ranging from 44 to 85. Our findings in a group of 13,000 men were similar to those in the above reports.

[1] From the Bond Radiological Group, Fort Worth, Texas. Presented as part of a Symposium on the Lumbosacral Spine at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

In an attempt to evaluate our program, we viewed the findings in 150 instances of back complaints which were prepared for litigation. In 122, or 81 per cent, of these, low back pain was the main complaint and records were made regarding the lumbosacral spine. From a study of the findings, an attempt was made to categorize these in one of the five classification groups described before this Society a few years ago:

Class I: No abnormalities.
Class II: Abnormalities not associated with clinical back complaints.
Class III: Abnormalities rarely associated with clinical back complaints.
Class IV: Abnormalities occasionally associated with clinical back complaints.
Class V: Abnormalities often associated with clinical back complaints.

Thirty-seven of the 122 lumbar spines were reported as being essentially normal. These would comprise our Groups I, II, and III. The average age of these men was thirty-three years. Twenty-three were in major accidents, 10 sustaining fractures or injuries in addition to those of the spine. Sixteen had no associated fractures and in this group settlement was for $10,000 or less. Settlement in the cases with associated fractures ranged up to $25,000.

There were 81 men, 66 per cent of the 122, who would have been placed in our Group V. In 27 of these there were multiple defects in the lumbosacral spine, consisting of old vertebral fractures, isthmus defects, spondylolisthesis, etc., none of which was considered recent trauma in the transcripts. In addition to multiple defects, there were in this group such single lesions as old fractures, sacralization with pseudoarthrosis, isthmus defects, interspace narrowing, hypertrophic arthritis, and spondylolisthesis. The compensation was high eight years ago and, with the recent trend, we could well expect it to be higher at the present time. For the 22 men with narrow interspaces, having an average age of forty-one years, compensation ranged from $5,000 for 4 men to over $35,000 for 2. For 8 men with isthmus defects (defects of the pars interarticularis), having an average age of thirty-one years, the range was from $5,000 in 1 instance to over $45,000 in 2. Nine men with old fractures, whose average age was thirty-four years, received compensation ranging from $20,000 in 5 cases to over $40,000 in 1. Twelve men with an average age of thirty-four years had partial sacralization, and 4 of these received compensation of over $10,000, while 3 were granted $35,000. For the 10 men with spondylolisthesis, with an average age of thirty-six years, compensation was from $10,000 for 2 to $35,000 for 2. The 27 men with multiple defects, averaging thirty-four years of age, received remuneration from $5,000 (7 cases) to $66,000 (2 cases). There were 22 men, averaging thirty-nine years of age, with hypertrophic changes. Compensation in this group ranged from $5,000 for 9 to over $30,000 for 2.

TABLE I: MAJOR DEFECTS FOUND IN 13,000 CONSECUTIVE PREPLACEMENT EXAMINATIONS OF THE LUMBOSACRAL SPINE

Marked narrowing of lumbosacral joint space	54	(0.4%)
Isthmus (pars interarticularis) defects	984	(7.6%)
Fractured vertebral bodies	39	(0.3%)
Fractured transverse processes	20	(0.16%)
Sacralization with false joint	533	(4.1%)
Spondylolisthesis	489	(3.7%)
Hypertrophic changes (marked)	117	(0.9%)
Lipiodol in spinal canal	12	(0.09%)
Evidence of previous surgery	11	(0.08%)
Scoliosis (deviation more than 10 mm.)	169	(1.3%)
	2,428	(18.63%)

After a review of this material, we concluded that the above mentioned conditions were certainly the most significant in causing lost time and medicolegal problems. We found in a series of 13,000 men examined (Table I) that 54 men were listed as having marked narrowing of the lumbosacral joint space, 380 as having narrowing up to 50 per cent, and 24 narrowing of an interspace above the lumbosacral level. A total of 984 had defects of the pars interarticularis. Thirty-nine men had old compression fractures of vertebral bodies, with 20 having transverse process fractures and 12 fractures about the pelvis and hips. Sacralization occurred in 533, with a false

joint or pseudarthrosis, bilateral in 208. Four hundred and eighty-nine had spondylolisthesis, and in 11 cases this was above the last lumbar vertebra. Marked hypertrophic changes, spurs of over 5 mm., or a tendency to bridging across an interspace were noted in 117 men, while 524 were found to have only minimal findings of this nature. In addition to these changes, there were 12 men with evidence of Lipiodol in the spinal canal and 11 that had been operated on about the low back, pelvis, or hips.

The conditions listed above, along with some other less frequent disturbances or combinations of minor defects, caused 20.5 per cent of the men examined to be placed in our Class V. This is less than in a similar classification of findings in 100 soldiers reported by Friedman, Fischer, and Van Demark.

We feel that our radiographic reports are accurate since, where at all possible, the examinations are carried out by diplomates of the American Board of Radiology, who realize the extreme importance of good technical examinations. They are then reported by the original examiner, and re-evaluated independently after being received for the company. Any discrepancy in the findings is rechecked, usually by a third radiologist. Many times the first reader will call attention to a defect which might have been overlooked. We feel that this combined effort has led to more accurate classifications. The radiographs, along with the hiring orders and original report, are then put on microfilm for safe keeping and further review as indicated.

As a result of these various findings, classification is made according to Groups I, II, III, IV, or V. These are reported to the operating department, with final interpretations and classification going to the system medical director. The men are then placed in positions which it is felt they may safely handle.

A survey revealed that 720 men had filed a report for back injury after our program had been in effect for four years.

TABLE II: ANALYSIS OF 60 INJURED MEN HAVING PREPLACEMENT EXAMINATION, 1952–1955

Total number	60
Average age	25 years
Minor injuries	
Strain, sprain, bruise	51
Time loss	
0–5 days	42
To 10 days	2
To 20 days	3
5 weeks	1
67 days	1
Separated (sued, disk)	2
Compensation	
None	18
Time loss	30
0–$150	2
Suits settled, $5,000	2
Major injuries	9
Time loss	
To 3 months	4
1 year	1
Permanent disability	2
Separated suit	2
Compensation	
Time loss	4
To $20,000	1
To $30,000	1
To $50,000	1
Pending	2

Only 60 of these men had obtained preplacement roentgen examinations of the back. Of these men, 17 per cent were in Class I, 40 per cent in Class II, 25 per cent in Class III, 12 per cent in Class IV, and 6 per cent in Class V.

The 10 men in Class I averaged twenty-seven years of age. Nine of these men had strains or sprains and 7 of them lost less than two days. Nine of the ten men settled for lost time only. One had settlement of suit for $5,000.

Of 24 men in Class II, average age 25.7 years, 18 lost less than five days, 1 less than ten, and 1 twenty-seven days. One was off two and one-half months for recurrence of an old sprain. Compensation for these 21 men was not in excess of wages for time lost. Only 1 employee in this group, alleged to have suffered a ruptured nucleus pulposus, presented a major area of disagreement in the medical financial field.

Fifteen men, with an average age of twenty-five, were in Class III, with 9 losing less than five days. One lost less than ten days and 1 less than twenty. All 12 of these employees were paid their regular wages, with no area of discord. The other

TABLE III: ANALYSIS OF INJURED MEN HAVING PREPLACEMENT EXAMINATION, THIRTEEN MONTHS IN 1956–1957

Total	34
Average age	28 years
Average length of service	34 months
Application rejected less than one week	1
Suit filed	pending
Minor injuries	
Strain, sprain, or bruise	26
Time loss	
None	9
To 5 days	12
To 15 days	5
Compensation	
None	10
Time loss	12
To $500	4
Major accidents	
Multiple fractures	7
Time loss	
To 3 months	3
Pending	4
Compensation	
To $1,500	2
To $5,000	1
Pending	4
Suit for disk injury	1

3 received injuries not specifically related to the low back area.

Seven men, averaging twenty-four years of age, were in Class IV. Six lost two days or less and posed no problem. One presented a problem of moderate financial and medical disagreement and settled his suit for $5,000.

Four men, average age twenty-three years, were in Class V. None of these had spondylolisthesis, old fractures, or any of the abnormalities discussed previously. Three of the group were off three days or less and one was off sixty-seven days. None posed a medical or financial problem.

A further analysis of the benefit of this program has just been completed. In the past thirteen months, there were 139 reports of back injuries. Thirty-four of these men had obtained preplacement back examinations (Table III). Of these, 30 per cent were in Class I, 26 per cent in Class II, 20 per cent in Class III, 9 per cent in Class IV, and 15 per cent in Class V.

The 10 men in Class I had an average age of thirty-one years and had worked an average of 36.4 months before injury. Two men had no time off, 4 lost less than five days, and 2 less than fifteen days. Only 2 of this group have presented possible complicating factors. The first received multiple fractures and the other, recently injured, has not yet returned to work.

Nine men in Class II, whose age averaged twenty-three years, had worked an average of thirty-five months before injury. Three of these men lost no time, 3 less than five days and 2 less than twenty days. With the possible exception of 1 man who was recently hurt and who has not as yet returned to work, there were no medicolegal complications.

Seven men in Class III, averaging twenty-seven years of age, had worked an average of twenty-two months before injury. Two of these men lost no time, 2 less than five days, and 1 less than ten days. In the case of 1 man with a disk injury, recovery is pending. One man whose application was rejected, with less than a week of service, has entered suit, which is also pending.

Three men in Class IV averaged twenty-nine years of age and had worked for an average of fourteen months before injury. Two lost no time. One man had multiple fractures and the outcome is pending.

Five men in Class V, having an average age of thirty years, had worked an average of sixty-one months before injury. Three of these men lost less than five days. The other 2 were off two and three months, respectively, because of fractured extremities and presented no medicolegal problem.

CONCLUSIONS

1. In 13,000 consecutive preplacement examinations, 20.5 per cent of the applicants were found to be in Class V, *i. e.*, to have abnormalities often associated with clinical back complaints.

2. Of the above group, 18.2 per cent were found to have conditions which had definitely caused prolonged loss of time and medicolegal problems.

3. The men placed in positions following these examinations had, on an average, worked many months without injury, thus eliminating the more immediate disability seen in the so-called "unstable back."

4. As a result, time loss due to minor injuries, as strains, sprains, or bruises, has been markedly reduced. This is in contrast to time loss and compensation previously involved in similar accidents.

5. Even though the preplacement examination is an excellent method of excluding certain defects of the lumbosacral spine, it will not exclude disk problems or prevent fractures when major trauma is sustained.

ACKNOWLEDGMENT: We would like to express sincere appreciation to the Radiologists who are participating in this Preplacement Program.

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SUMMARIO IN INTERLINGUA

Le Valor Del Examine Del Spina Lumbar Ante Le Placiamento Del Mano De Obra

Nulle condition, quanto a obreros qualificate, causa plus alte perditas de horas de labor que symptomas de dolor infero-dorsal. Un del medios que pote corriger iste situation es le examine preplaciamental del spina lumbosacral pro conditiones que predispone le individuo a suffrer tal injurias.

In 13.000 consecutive examines preplaciamental il esseva trovate que 20,5 pro cento del candidatos habeva anormalitates que es frequentemente associate con clinic disordines dorsal. Inter istes, 18,2 pro cento habeva conditiones recognoscite como causa de considerabile perditas de tempore e de problemas medicolegal. In le majoritate del casos, le obreros installate post iste examines laborava sin injuria durante multe menses, de maniera que le invaliditate immediate que occurre con le si-appellate "dorso instabile" esseva eliminate. Le resultato esseva un marcate reduction del perditas de tempore e del demandas de compensation in consequentia de injurias minor.

Ben que le examine preplaciamental es un excellente methodo pro excluder certe defectos del spina lumbosacral, illo non pote excluder problemas de disco intervertebral o prevenir fracturas in caso de trauma major.

Role of the Radiologist in Management of Low Back Pain[1]

JAMES K. STACK, M.D.

WHEN I WAS assigned the subject of the management of low back pain, I had a little difficulty figuring out just what radiologists would want to know about this matter. I decided to limit myself to the role of the radiologist in the treatment of this syndrome rather than bore you with thoughts on bedboards, corsets, casts, exercises, manipulations, the buzzing of electrical devices, myelograms, operations, the question of when to fuse and when not to fuse, and so on.

The radiologist can, of course, play an active role in the management of certain kinds of low back pain. He can certainly actively help the patient with early rheumatoid spondylitis and the patient with lymphoma of the third lumbar vertebra. But his role in treatment in most of the conditions that cause pain in the lower back must necessarily be a passive one.

I suppose it could be said that even the taking of roentgenograms, the making of the films, does help many patients in an active way. Indeed, you would be surprised at the number of people seen each year who have been given opinions of one kind or another about their back complaints and have had various courses of treatment, yet never have had a roentgen examination as part of the initial study. I am sure you all realize the great impact your equipment, and the use of it, has on patients in general, and how seriously the cursory, hastily done clinical examination suffers by comparison. The patient whose back examination has been limited to the "loosen-your-belt-and-pull-your-shirt-up" variety is indeed comforted in the X-Ray Department because he feels that, for the first time, he is getting a real examination; that the pictures will certainly show his trouble, and maybe now he won't have to spend so much time and money on "diathermy and shots." Those of us interested in the back problem from the clinical standpoint also have some helpful props, but our hammers, tuning forks, needles, etc., make less of an impression, though, to be sure, they are much less expensive. This then is one way in which the radiologist plays a role in the management of the painful lower back.

There is another way in which he can help, and this is by the type of report he writes. By this I mean the emphasis, or lack of it, that may be placed on certain positive findings and on certain negative findings. A third way is the beaming of the report to a certain type of recipient. You know what I mean by this. In a community, there are various kinds of medical recipients: those in general practice who refer their patients for x-ray examination may be divided into those who are interested in back problems and those who are not. Those doing general surgery, and who have an interest in trauma, can be placed in the same two divisions, and, finally, there is the orthopedic group. There is only one division here because the members of this last group are invariably interested. They have to be, because a good share of their living comes from the management of low back disorders. Now, it is my thought that you can serve the cause of the patient who is under the care of any one of these groups by varying the wording and the emphasis in accord with your impression of the diagnostic abilities of the recipient. You are dealing with the entire medical community in which you live and work, and it seems to me that you should be able to know them well enough for this.

We both know that the orthopedic surgeon is going to view and interpret the films. Actually, the patient was sent to

[1] From the Department of Orthopaedic Surgery, Northwestern University Medical School, Chicago, Ill. Presented as part of a Symposium on the Lumbosacral Spine at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

you, in most instances, because you have the equipment to give this specialized service. There are exceptions, of course, in which the surgeon will want to go over certain problems from the radiologist's point of view, but, by and large, he is probably called upon to interpret more lumbar spine films year in and year out than are you. So why waste your time recording things or giving impressions that are not going to help him in the management of the particular patient. In dealing with the orthopedist who is himself interpreting the films, some conflict might arise in the mind of the patient, who likes to see the x-ray report and the films. It is difficult sometimes for the clinician to nullify by word of mouth what has been made a part of the written record. It is difficult for him to make a negative thing out of a positive one. "The x-ray shows it. Therefore, it must be the cause of my trouble." It is only human to rely on the concrete, discernible finding rather than on the abstract, nebulous word. For instance, I like to have a radiologist suggest from time to time that a certain finding should be dependent upon clinical correlation, or the lack of it.

So much, then, for the man who knows as much as you do about the lumbar spine. Now, what about the man who doesn't, the one who encounters these problems infrequently, or who hasn't yet been thoroughly initiated into all of the joyous and sorrowful mysteries of the low back. You know all about him, but the patient doesn't, and you know the patient doesn't, or he wouldn't be there. What is your obligation to him? Or don't you have one? Is a cold, factual, stereotyped report the best you can do to help in the treatment or management of this patient? Or can you, in an unobtrusive way, give this medical recipient a quick refresher course, so that he can better manage the problem? I have colleagues in your field who do such teaching, and it is so smooth and painless that the recipient never knew he was learning something. Is it a radiologic sin to say that a film of the knee cannot rule out all forms of internal derangement, or that films of the spine do not show metastatic lesions that have not yet eroded bone, or a posterior penetrating peptic ulcer, or a herniated nucleus pulposus? Most of the errors that these recipients of yours will make are those of omission—the diagnosis never enters the mind—rather than those of commission by which it is entertained, balanced with other possibilities, and then rejected. Is it wrong to mention a few possibilities in certain reports so that the danger of the error of omission will be less? To be sure, you may offend some touchy people, but it's your job to know when that risk should be taken for the ultimate benefit of the patient.

The roentgenogram is a very important element in our work, but the longer one is in a certain related field the more he understands its limitations. The layman, or the uninitiated doctor, is much more likely to place his chief reliance on the x-ray picture than the experienced specialist. My preceptor, Paul Magnuson, used to say: "The x-ray is like the light that lies in a woman's eyes—it lies, and lies and lies." I think this questioning attitude toward any laboratory examination is a wholesome one. It is the inexperienced who usually place more reliance on any kind of a laboratory finding than on their own interpretations of clinical findings. And, along this same line, I wish that one of you gentlemen would invent a bright red coating that would withstand the developing and fixing solutions, that could be used to color the film holders used in emergency work. This would remind the intern or resident who is looking at wet films taken on a patient on the emergency service that there is danger in front of him; that the x-ray may not tell the whole story; that it is only part of the examination. The history and physical examination are still standard procedures, though x-rays and antibiotics do help.

Now, there is another kind of medical recipient. He differs from the others in that he knows exactly what he wants, and, if you don't give it to him, he'll take his

business elsewhere. But, if you do give it to him, you think you are helping in the treatment and rehabilitation of the poor litigant who is a pawn in a tricky, smelly, medicolegal situation. You can keep him from working for many more months by improper or unwarranted emphasis on certain positive findings.

There is another question that is germane to our working together in the management of low back disorders, and that is: What are the points of primary interest in these lumbar films, and what are the things that interest us? Paul C. Williams, who for many years has been an active worker and teacher in this field, says: "The final interpretation of the films is the responsibility of the orthopedist who has examined the patient. However, any controversy is usually insignificant once the radiologist becomes familiar with the changes with which the orthopedist is concerned." This is taken from Vol. X of the Instructional Course lectures of the American Academy of Orthopaedic Surgery, 1953, and I am sure you would benefit by reviewing this article. It is my good fortune to have the opportunity to review many films and many reports, mostly on pre-employment examinations of the lumbar spine, on applicants for railroad jobs. These come from a number of midwestern states in which the Chicago & North Western Railway operates. It is apparent, and has been for some time, that many radiologists do not have the same interest in the lower lumbar facets that we do. Many reports are notable for the absence of any mention of these facets, their size, position, contour, relationship to each other and to the body of the vertebra above, the marginal changes about them, etc. I need not remind you that these facets are the true joints of the spine. They are just as much a joint as the ankle. They contain subchondral bone, which is capable of reaction, distress, degenerative change, and other inflammatory conditions. They have hyaline cartilage, synovial membrane, joint fluid, supporting ligaments, and they are subject to the same traumatic and degenerative ills as any other weight-bearing joint. But, instead of being palpable just under the skin, as is the ankle, they are buried deeply from the sight and feel of the examiner. They are also buried too deeply many times in the report of the radiologist, if they are mentioned at all.

Nature devised the lumbar spine to function in segments with the vertebral bodies and facets a certain distance apart, and the intervertebral disks were interposed to maintain this distance. When the nucleus pulposus loses its shock-absorbing resiliency and begins to wear and thin out (as any gasket will in time), one vertebral body will then tend to settle on the subjacent one. At a certain point, this becomes obvious on the x-ray film and the report will mention it, together with a note about the reactive hypertrophic changes that accompany it. But too many reports will not mention the change that must take place in the relationship of the facets. We must remember that in the lower lumbar spine the weight of the body is borne posteriorly and that sheering forces are applied to these true joints. The hypertrophic change that occurs at the vertebral body margins is not arthritis, simply because there is no true joint at these points. The changes that take place in and around the facets are arthritis because these are the true joints of the spine. The disk substance, the cartilaginous plates, the vertebral osteophytes are not highly innervated pain sources, but the structures about the facets are.

The herniation of the disk nucleus is an important source of sciatic pain reference, but such pain and objective neurologic findings can also be caused by reactive change in the capsule and subchondral bone of the facets. These facet changes are certainly the most important elements in low back pain disability without radiation into the leg.

All of us dealing with low back pain (and few in the practice of medicine can escape it) will benefit by the radiologist's awareness of the importance of these structures. Perhaps it would be well to remind the

medical recipients of your reports of the potential of the facet in this common ailment.

Now is there any other way in which you can be helpful in the management of these patients? You have all had the experience of getting a call from one of the recipients of your reports saying, "I have your report; now what do you think we should do? How about a myelogram?" You, the radiologist, participate in the performance of the myelogram. Do you have anything to say about its indications? What is your attitude on myelograms? Do you consider it a diagnostic or confirmatory test? Is there any danger in this test? Is there any chance of harm coming from residual iodized solution in the subarachnoid space, from that covering the cerebral cortex to the filum terminale and extending laterally in the nerve root extensions? Is this test as innocuous as a stomach and outlet study, as a cystogram, as a bronchogram? It is the feeling in our group that the instances that call for a myelogram without objective neurologic findings are few and far between. If you cannot demonstrate reflex, sensory, motor, or trophic change, then the myelogram is an empirical test and will probably add to the general confusion.

This is but one example of many quandaries in which you may find yourself in your daily work; I am sure there are others. But the point is that in these situations you must be more than an overseer of technicians or an interpreter and critic of films. Your place in the practice of medicine, in its broad sense, is unique in that you are a specialist in a medium in which the public and many, many doctors have an almost naïve confidence. Are you going to exploit this naïveté and bolster your own ego by giving the impression that yours is the final word, or are you going to remember that "doctor" means literally "teacher?"

SUMMARY

It has been pointed out that the role of the radiologist in the management of low back pain must necessarily be largely a passive one. In the first place the radiologic examination is a source of satisfaction and confidence to the patient. The radiologist can also help by making his report with the type of referring physician in mind, varying the wording and emphasis in accord with the diagnostic abilities of the latter.

It is important, also, that the radiologist bear in mind the primary points of interest in the low back film, notably the lumbar facets, *i.e.*, the true joints of the spine, which are subject to the same traumatic and degenerative ills as other weight-bearing joints. Too often the radiological report omits any mention of these important structures.

The subject of myelography is touched upon briefly. It is believed that instances calling for this procedure in the absence of objective neurological findings are few.

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SUMMARIO IN INTERLINGUA

Le Rolo Del Radiologo In Le Tractamento De Dolor Infero-Dorsal

Le rolo del radiologo in le tractamento de dolor infero-dorsal debe esser, necessarimente, de natura predominantemente passive. Primo, le examine radiologic es un fonte de satisfaction e de confidentia pro le patiente. Le radiologo pote etiam esser de adjuta per rediger su reporto specificamente pro le typo de medico in question, i.e. per variar su phraseologia e su emphase de accordo con le capacitates diagnostic de ille. Si le adressato del reporto es un chirurgo orthopedic, i.e., un individuo probabilemente tanto familiar con le problemas de dolor infero-dorsal como le radiologo mesme, il es forsan bon sublinear le dependentia de certe alterationes roent-

genographic ab le presentia (o absentia) de associate constatationes clinic. Si le adressato es medico e assi minus familiar con le problema, le reporto pote discretemente offerer certe suggestiones que va esser de adjuta in le manipulation del caso.

Il es etiam importante que le radiologo presta attention al punctos de interesse primari in le radiogramma infero-dorsal, notabilemente le facettas lumbar, i.e., le ver articulation del spina dorsal que es susceptibile de suffrer le mesme males traumatic e degeneratori como non importa qual altere articulation que supporta un peso. Troppo frequentemente le reporto radiologic omitte omne mention de iste importante structuras.

Le thema del myelographia es toccate brevemente. Es exprimite le opinion que le casos que require un myelogramma in le absentia de constatationes neurologic es sparse e infrequente.

DISCUSSION

(Papers by Meschan and Farrer-Meschan; Ghormley; Simril; Moreton, Winston, and Bibby; Stack)

John R. Winston, M.D.[1] (Chicago, Ill.): There are certain points that have been made in this Symposium that I should like to highlight briefly. In Dr. Ghormley's presentation I noted especially the dearth of problems attributable to the narrowed lumbosacral space, partial sacralization with false joint, changes in the lumbosacral angle, and anxiety states.

There are two points I shall emphasize in connection with Dr. Simril's remarks. One has to do with the person who has suffered a previous injury and the other with a situation of long standing either with or without injury. Whether a man's present condition is due partially or totally to recent trauma, from a litigation standpoint we are faced with the problem of compensation not on a *pro rata* basis but on the basis of the dependence, or independence, of the complaint upon some pre-existing condition.

All of the 13,000 men upon whom Dr. Moreton reported had undergone a satisfactory physical entrance-into-service examination. This means that those persons who had had previous back surgery or those with Lipiodol in the subdural space were actually not candidates for the low-back investigation, which amplifies a point that Dr. Stack made—that the drop-your-pants-and-shift-your-shirt type of back examination is sometimes even a little shorter than that.

I would like to make two other rather obvious comments: First, the x-ray investigation of the low back area as part of the preplacement employment program is not expected to eliminate all complaints of low back pain from the employee population nor, on the other hand, is it designed to bar a person from employment. However, just as certain areas of visual acuity are mandatory in some occupations, musculoskeletal stability is likewise highly desirable in certain categories of employment. Second, the value of the pre-employment investigative procedure is, I think I can say, without exception in direct proportion to the interest of the examiner and accuracy of the examination. As regards the present problem, it has been our observation that these latter factors are best illustrated by those physicians who have had proper radiological training. We welcome, in fact encourage, the local radiologist to pass on to us in addition to his interpretation of the roentgenograms any comment that he may have that may be of benefit.

Our present program of preplacement x-ray investigation of the low back area has been a cooperative effort in which many radiologists, orthopedic surgeons, and other interested physicians have taken an active part. In the area between Chicago and the Gulf of Mexico on the south and the Pacific Coast on the west, there are many communities, both large and small, some with and others without the services of a physician who has had minimal training in radiology. It follows, therefore, that we accept the services of some x-ray examiners who are not radiologists in a strict sense of the word. On the basis of my own experience as a guide, and only my own, I would say that there are some whose x-ray investigations are superior in quality, others whose work is of inferior quality.

However, to rephrase a statement made a few minutes ago and also borrowed from an advertising slogan, we expect more from radiologists and we almost always get it. The fact is that there are still many areas in this field which are as yet insufficiently explored or understood, although x-ray investigations of this type have been practiced certainly for well over thirty years.

Just a word to those who might be interested in organizing or promoting a program of this type. There are certain fundamental principles which I would suggest that you keep in mind. The first and most important one is that you should have a definite understanding of the objectives of the program. Second, you should have an idea as to the

[1] Medical Director, Santa Fe Railroad.

relative importance of the pathology encountered. Third, the physical requirements of the employees in various job classifications must be well known to the director of the plant. Fourth, in those instances in which the program involves numerous x-ray examinations, radiographic interpretations of the local radiologists are important and highly desirable, even though roentgenograms from all sources are subject to review by the chief radiologist. This last examination, the overall survey, is most important in order to obtain uniformity in technic and interpretation. Fifth, and last, roentgenograms of good technical quality are an absolute necessity. This is a trite statement, and I am sure it is not needed by any members of this particular audience. I can assure you, however, that it has been a subject of considerable concern to us. Technological advances should be made an integral part of the program as soon as their value becomes adequately demonstrated.

Relation Between Cardiac Failure and Gastric Ulcer in the Older Age Group[1]

MICHAEL M. KLEIN, M.D., and EUGENE L. WALSH, M.D.

THERE IS NO more controversial subject in the medical literature than the pathogenesis of gastric and duodenal ulcer. To review all the literature dealing with this problem is beyond the scope of this paper. We would like, however, to refer to one overlooked fact which seems to be of importance, namely that acute and chronic gastric ulcers are frequently found at autopsy in persons who have died from seemingly unrelated causes. The state of nutrition of the gastric mucosa at different points and the functional disturbances and chemical changes in the development of a chronic ulcer are well known. To the more familiar etiological factors we believe there should be added cardiac decompensation of various degrees and secondary arteriosclerotic heart disease.

In an earlier study on gastric ulcers in the older age group, one of us (M. M. K.) noticed a rather high percentage of gastrointestinal complaints among cardiac patients. It was believed that "indigestion" in this group was due either to congestion of the gastric mucosa or to the irritating effect of medication (digitalis). Little attention was given to the fact that, parallel with the improvement in the cardiac condition, there was amelioration of the gastrointestinal symptoms.

We have noticed, on many occasions, that, in patients with a questionable diagnosis of malignant ulcer in whom operation was postponed because of cardiac decompensation, healing of the ulcer occurred as the cardiac condition was alleviated, and frequently a healed ulcer was encountered on exploration. A search of the literature, however, revealed no reference to the relation of cardiac failure and ulcer.

TABLE II: DISTRIBUTION OF GASTRIC ULCER BY AGE AND TYPE OF CARDIAC DISEASE

Age	Hypertensive Heart Disease	Arteriosclerotic Heart Disease	Coronary Heart Disease	Cardiac Failure	Total
Under 40				2	2
40–50			2	1	3
50–60		10	12	10	32
60–70	7	12	22	17	58
Over 70		6	4	10	20

MATERIAL

During the six-year period between Jan. 1, 1951, and Dec. 31, 1956, 1,187 new cardiac cases were seen in our hospital. This does not include readmissions. Rheumatic and valvular heart disease are also excluded, first because these patients belong in the younger age brackets, in which gastric ulcer is not common, and second because ulcer was never encountered in this group even in the presence of severe failure.

Of the 1,187 cardiac patients, 370 or 31.2 per cent had gastrointestinal symptoms of sufficient degree to warrant roent-

TABLE I: TYPES OF CARDIAC DISEASE IN 1,187 PATIENTS

	No. Cases	Age			Cases with Gastrointestinal Symptoms	Cases with Positive Findings	Per Cent of Total Cases
		Highest	Lowest	Av.			
Hypertensive heart disease without failure	193	85	27	60.4	34 (17.1%)	7 (20.6%)	3.6
Arteriosclerotic heart disease without failure	333	90	36	64.2	99 (29.7%)	28 (28.3%)	8.6
Coronary heart disease without failure	343	92	33	63.1	128 (37.3%)	40 (31.2%)	11.7
Congestive heart failure	318	87	38	61.8	94 (29.6%)	40 (42.5%)	12.4

[1] From the Veterans Administration Hospital, Huntington, W. Va. (M. M. K., Chief of Radiology Service; E. L. W., Chief of Medical Service). Presented at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 17–22, 1957.

gen examination; in 115 of this number, or 31 per cent, the findings were positive for ulcer. The ages of the patients ranged from twenty-seven to ninety-two; the average was sixty-three years.

The types of cardiac disease in this series are shown in Table I: 193 patients had hypertensive heart disease, and 34 of these, or 17.1 per cent, exhibited gastrointestinal symptoms, with positive findings in 7, or 3.6 per cent. Arteriosclerotic heart disease and coronary heart disease are closely related and showed an almost identical result. Of 333 patients with arteriosclerotic heart disease, 99, or 29.7 per cent, complained of gastrointestinal disturbances, and in 28 of these, or 8.6 per cent, positive findings were obtained. Of the 343 patients with coronary heart disease, 128, or 37.3 per cent, had gastrointestinal complaints and in 40, or 11.7 per cent, the x-ray findings were positive.

We examined also 318 cases of cardiac failure without regard to the basic type of heart disease and obtained findings very similar to those in the arteriosclerotic and coronary groups. These data, however, are not quite accurate because most of the patients were examined only when the acute stage of heart failure had passed and they could be classified in one of the other groups.

For comparison, and to satisfy our curiosity, after the above study was completed, we examined 53 consecutive cardiac failure cases (Jan. 1 to June 30, 1957) regardless of the type of heart disease and regardless of whether or not gastrointestinal symptoms were present. The examinations were done on admission or shortly thereafter, while the patients were still in acute failure. Fifteen, or 28.3 per cent, of the 53 had gastric ulcers, which is a much higher incidence than in the earlier failure cases.

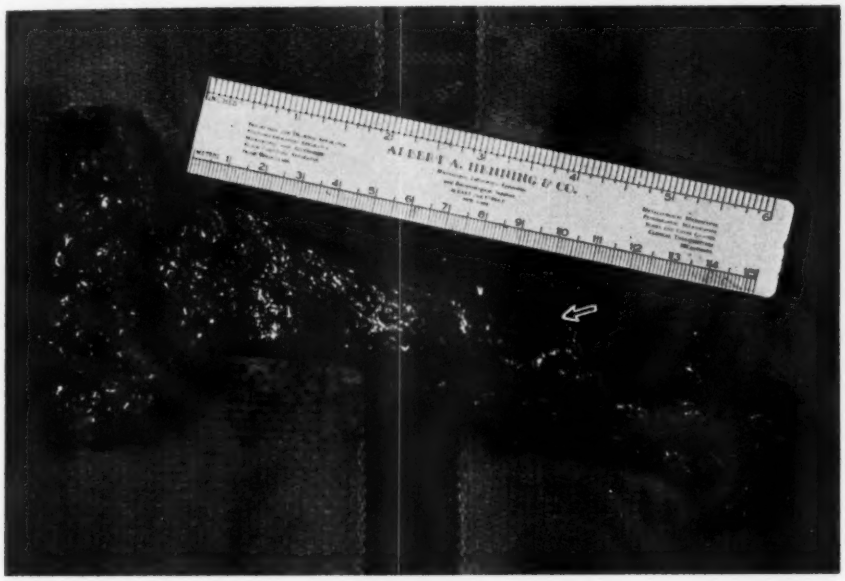

Fig. 1. Case I. Sleeve resection of the ulcer. The arrow points to the gaping, sclerotic, eroded artery.

It is well known that gastric ulcer is a disease of older persons (Table II). The age incidence in patients with cardiac disease is about the same as in noncardiacs, the greatest prevalence being between fifty and seventy.

CASE HISTORIES

CASE I: S. C., a 70-year-old white male, entered the hospital on Nov. 30, 1955, because of severe chest

Fig. 2. Case II. Slightly edematous mucosa; small filling defect on floor of ulcer.

pain. He stated that he had been well until ten days before admission. He had never had stomach trouble. Three days earlier he had experienced some epigastric pain and vomited blood. Meantime the chest pain which brought him into the hospital had grown gradually worse.

On physical examination no significant abnormality was found. The blood pressure was 110/70; pulse 92. Visible arteries were tortuous and hard. Because the patient entered the hospital late in the evening, no routine x-ray and laboratory studies were made.

A few hours after admission, a gastric hemorrhage suddenly occurred. Despite intensive treatment and blood transfusions, the bleeding continued, with a drop in red cell count to 1,960,000 and in hemoglobin to 8 gm. per 100 c.c. Because of the futility of further conservative treatment, surgery was undertaken. A sleeve reaction was done. On the lesser curvature of the stomach, a large, relatively shallow ulcer was found, with an eroded, gaping sclerotic artery on its floor (Fig. 1).

Interestingly, this man had been a patient in our hospital five years earlier because of fractured ribs sustained in a fall. On that admission he had no gastrointestinal complaints. His heart was slightly enlarged, but otherwise there were no positive findings.

We saw several cases of this type. In some of these there had been a previous roentgen examination; in others not. We were intrigued with this case and wondered whether there were any signs by which we could possibly predict a threatening hemorrhage. We were successful only once.

CASE II: H. M. K., a 52-year-old white male, was admitted June 7, 1957. He had no cardiac complaints but stated that he had suffered from stomach trouble all his life. Three months before admission

Fig. 3. Case III. Edematous mucosa; no ulcer. Cardiac enlargement with congestion.

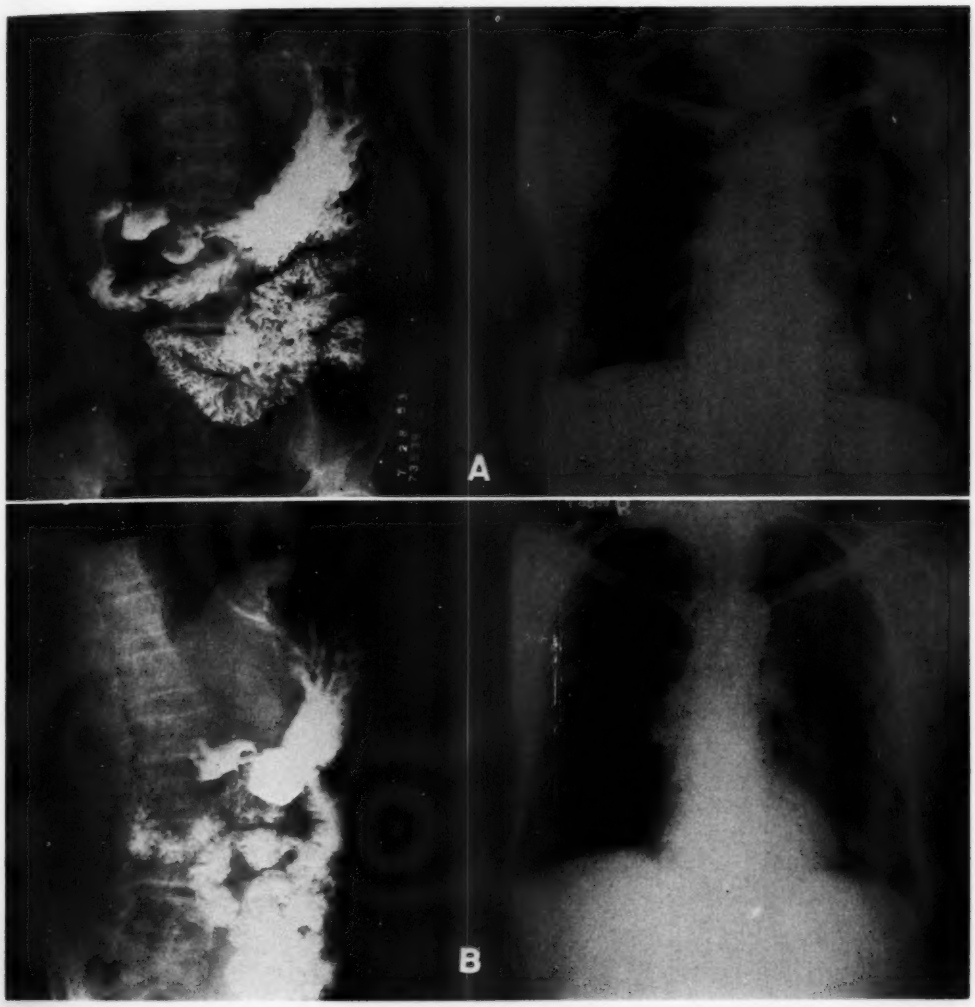

Fig. 4. Case IV. A. Admission films, showing edema of the gastric mucosa and an enlarged, hypertensive heart; no congestion.
B. Films obtained after treatment of the cardiac condition: stomach normal; heart somewhat smaller.

this became worse and he occasionally passed tarry stools.

The patient appeared pale. There were sibilant râles in both lung bases. The heart was normal in size, with diminished sounds and a soft apical systolic murmur. The retinal vessels had a silver-wire appearance. The blood pressure was 118/80. The electrocardiogram was normal. Other findings were as follows: urine negative; nonprotein nitrogen 69 mg. per cent; white cell count 11,050; hemoglobin 4.5 gm. per 100 c.c.; hematocrit 19.5 vol. per cent; feces ++++ for occult blood. The admission diagnosis was peptic ulcer and generalized arteriosclerosis, Grade III.

A roentgenogram, two days after admission, showed a small lesser-curvature ulcer with a filling defect the size of a millet seed on its floor, interpreted as a vessel (Fig. 2). Preventive surgery was suggested, but this suggestion was ignored and the patient was kept on a medical regime. The tarry stools ceased and it seemed that he was getting better, but three days later he had a massive, uncontrollable gastric hemorrhage and went into a state of shock. At emergency operation, a lesser curvature ulcer, 1.5 cm. in diameter, was found with a gaping, eroded, sclerotic vessel on its floor, as seen on the x-ray film. Unfortunately, no photograph of the specimen was obtained.

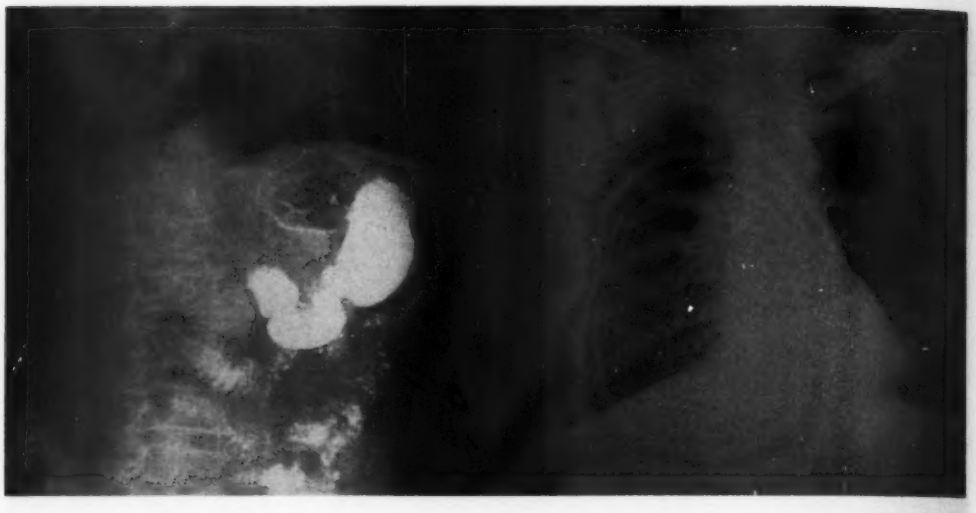

Fig. 5. Case V. Sessile ulcer on lesser curvature. Slight cardiac enlargement; questionable congestion.

Most of the ulcers in cardiac patients, single or multiple, are not deep and rarely penetrate the muscularis or beyond. Large or small, they are usually sessile. The ulcers can be so small that they are not demonstrable, and only marked edema of the mucosa may be seen.

CASE III: D. H., colored male, aged 57, was admitted Oct. 20, 1951, complaining of shortness of breath for six years. This had become gradually worse, and the patient now had swelling of the legs and ankles. The day before admission he vomited some blood.

Physical examination showed severe exertional dyspnea. The blood pressure was 130/98; pulse 104. The second pulmonic sound was greater than the second aortic. The electrocardiogram was indicative of sinus tachycardia and myocardial damage. The stools were positive for blood (guaiac test +++). Gastric analysis showed free hydrochloric acid 43°, total acid 52°. Roentgen examination demonstrated enlargement of the heart with pulmonary congestion; the gastric mucosa was edematous but no ulcer was seen (Fig. 3).

On cardiac management, the gastric complaints improved along with improvement of the cardiac symptoms.

In this case the connection between ulceration with bleeding (+++ guaiac) and cardiac failure is definitely proved by the fact that cessation of bleeding occurred following correction of the cardiac decompensation.

CASE IV: A. V., a white coal miner, 59 years old, was sent in by his physician because of an uncontrollable gastric hemorrhage. He stated that he had been examined many times and had been told that he had high blood pressure and arteriosclerosis.

On physical examination the heart was found to be slightly enlarged, with a soft systolic murmur at the apex. The blood pressure was 150/110. A chest film showed an enlarged hypertensive arteriosclerotic heart; no congestion. A gastrointestinal series revealed slightly edematous mucosa but no ulcer (Fig. 4, A). The red cell count was 3,770,000; white cells 6,700; hemoglobin 13.5 gm. per 100 c.c.; guaiac test ++. Because of the persistence of anemia, operation was decided on as soon as the cardiac status should permit. On exploration no cause for bleeding was found.

A few months after the first admission the patient returned to the hospital for essentially the same reasons as before. At this time he improved rapidly on cardiac medication (Fig. 4, B).

In both of these cases (III and IV) the patients were suffering primarily from heart disease, but the cardiac symptoms were overshadowed by the more alarming gastric hemorrhage which brought them to the hospital. This is a situation which we meet quite frequently. Several cardiologists have told us that many of their cardiac patients have tarry stools at the height of the cardiac failure.

CASE V: K. E., white farmer, 67 years old, was admitted to the hospital March 7, 1956, complain-

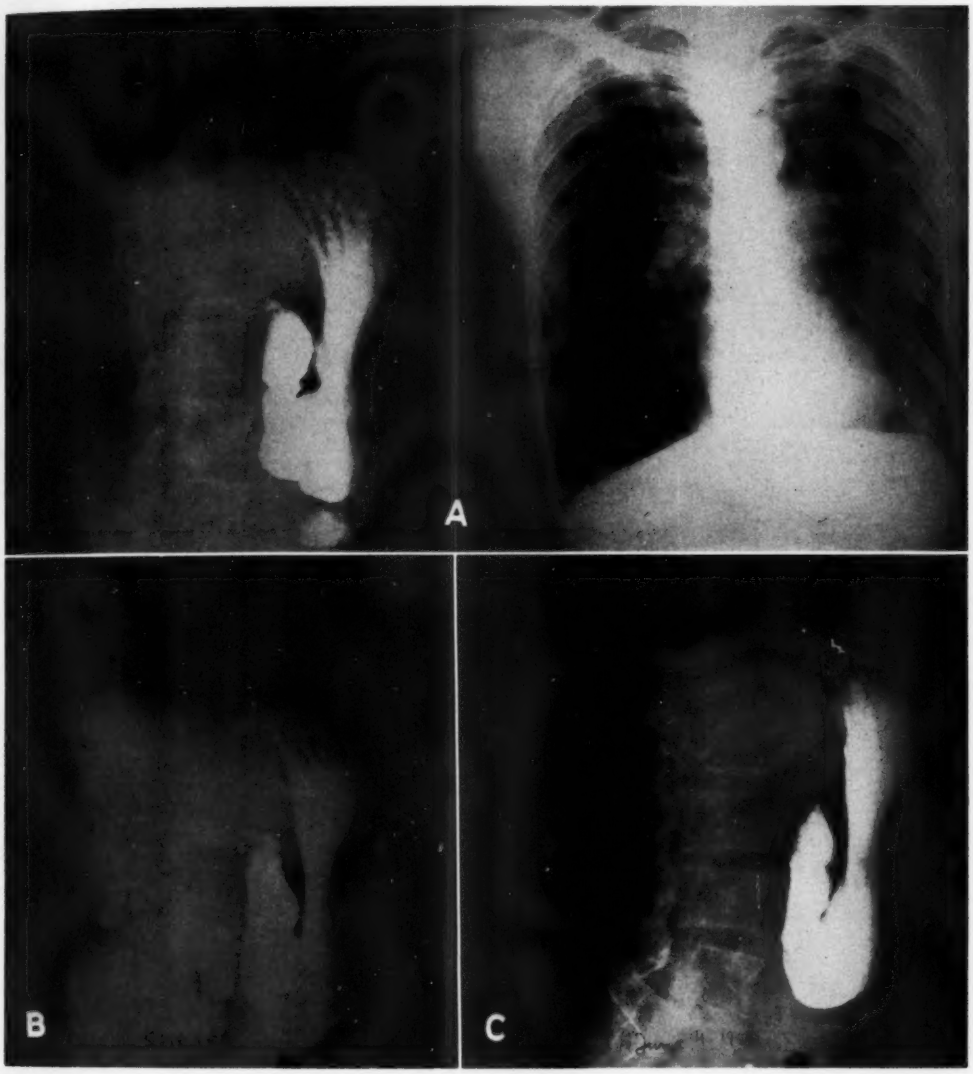

Fig. 6. Case VI. A. Initial films showing large sessile gastric ulcer and chest negative for congestion.
B. Two weeks later the ulcer is hardly demonstrable.
C. Six weeks after the initial film the ulcer has disappeared.

ing of shortness of breath and chest and abdominal pain for some time. He had never had stomach trouble.

The patient was a rather well developed elderly man showing marked exertional dyspnea. The heart was slightly enlarged, with a systolic murmur at the apex. The blood pressure was 204/100; pulse 64. The electrocardiogram showed frequent ventricular premature contractions. A chest film demonstrated slight cardiac enlargement, with questionable congestion. A gastrointestinal series revealed a small sessile gastric ulcer on the lesser curvature (Fig. 5).

Because of the old belief that every gastric ulcer is potentially malignant, this patient was operated upon two weeks later, when his cardiac condition permitted it. During this two weeks he received no treatment for the ulcer. At operation an almost healed shallow gastric ulcer was found.

Cases IV and V show clearly the connection of gastric ulcer and cardiac decom-

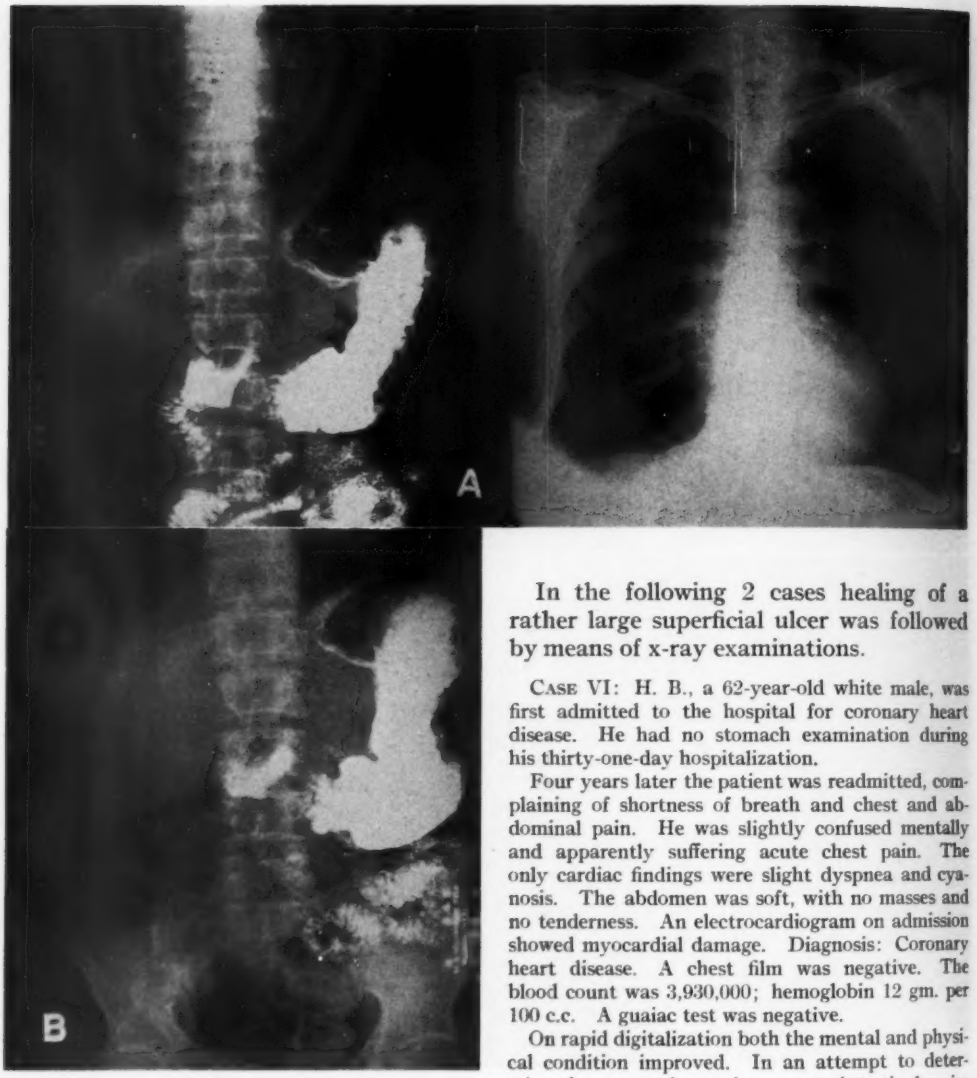

Fig. 7. Case VII. A. Sessile lesser curve ulcer and enlarged hypertensive heart; no congestion.
B. The ulcer healed.

pensation. In Case IV no ulcer was demonstrable by x-ray or at operation, though the patient showed very definite ulcer symptoms with hemorrhage. On a second admission, the ulcer symptoms responded promptly to cardiac management. In Case V the improvement of the gastric ulcer on cardiac management was clearly evident on exploration.

In the following 2 cases healing of a rather large superficial ulcer was followed by means of x-ray examinations.

CASE VI: H. B., a 62-year-old white male, was first admitted to the hospital for coronary heart disease. He had no stomach examination during his thirty-one-day hospitalization.

Four years later the patient was readmitted, complaining of shortness of breath and chest and abdominal pain. He was slightly confused mentally and apparently suffering acute chest pain. The only cardiac findings were slight dyspnea and cyanosis. The abdomen was soft, with no masses and no tenderness. An electrocardiogram on admission showed myocardial damage. Diagnosis: Coronary heart disease. A chest film was negative. The blood count was 3,930,000; hemoglobin 12 gm. per 100 c.c. A guaiac test was negative.

On rapid digitalization both the mental and physical condition improved. In an attempt to determine the cause of anemia, a gastrointestinal series was done twenty-eight days after admission and a large superficial ulcer was found (Fig. 6, A). On a maintenance dose of digitoxin and a bland diet the ulcer healed and two months later was no longer demonstrable (Fig. 6, B and C).

CASE VII: A. H., a 54-year-old white man, was admitted March 19, 1957, because of shortness of breath requiring oxygen. He complained of chest pain but had no gastrointestinal symptoms.

Physical examination showed severe dyspnea and mild cyanosis. The heart appeared enlarged. The blood pressure was 160/100. An electrocardiogram showed left axis deviation. The red cell count was 4,270,000, the white cell count 11,500, hemoglobin

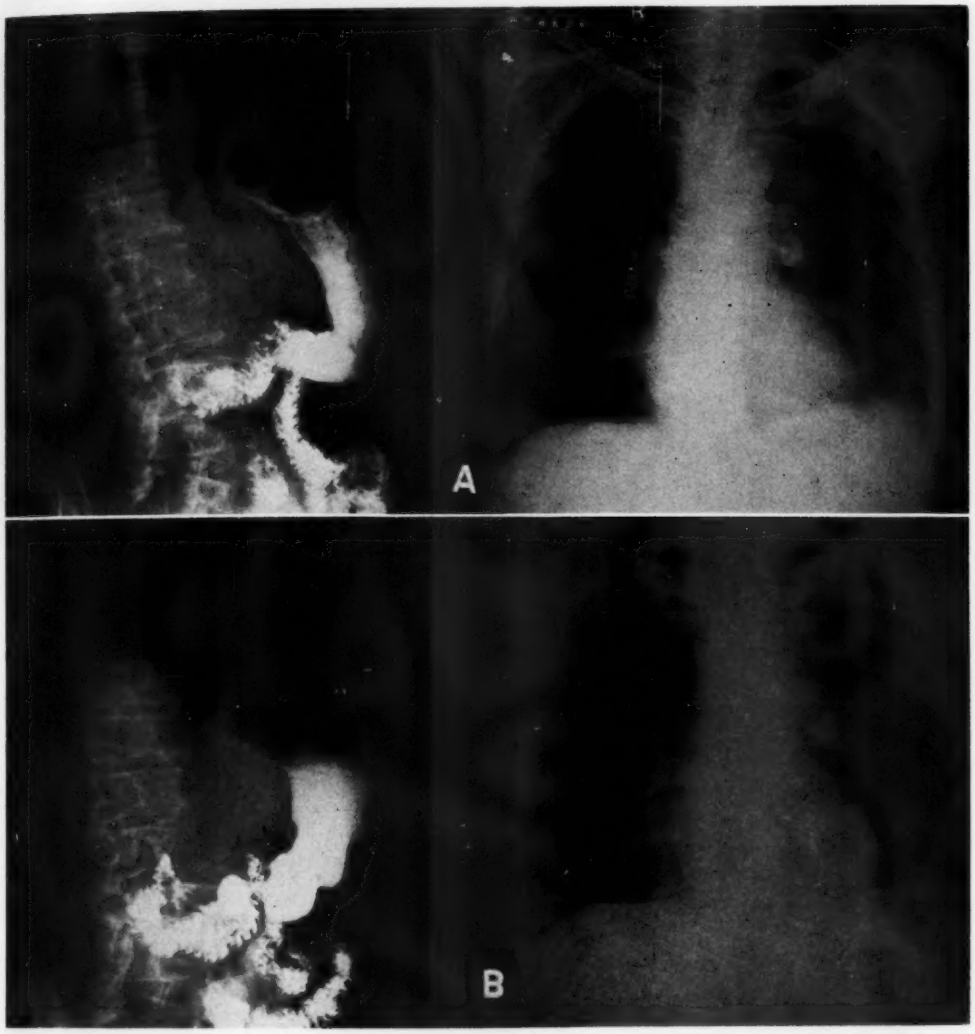

Fig. 8. Case VIII. A. Typical edematous mucosa; no ulcer; enlarged hypertensive heart; slight pulmonary congestion.
B. Four months later: mucosal pattern flattened; large sessile ulcer on lesser curve; enlarged heart; slight congestion.

14 gm. per cent. The guaiac test was positive (++).

A chest film showed a hypertensive heart, but no enlargement and no pulmonary congestion. Two weeks following admission a gastrointestinal series revealed a large sessile ulcer (Fig. 7, A). A month later (Fig. 7, B) this was no longer demonstrable.

In neither Case VI nor VII were there any formal ulcer complaints, nor was a gastrointestinal lesion suspected clinically. The large ulcers, demonstrated roentgenologically, cleared completely following treatment of the cardiac condition.

In other cases, in spite of clinical symptoms, no ulcer was found on the first and second examinations, but one was subsequently demonstrated.

CASE VIII: J. N., a white male, aged 81, was admitted to the urological service because of urinary retention. He had no complaints referable to the stomach. Physical examination showed cardiac

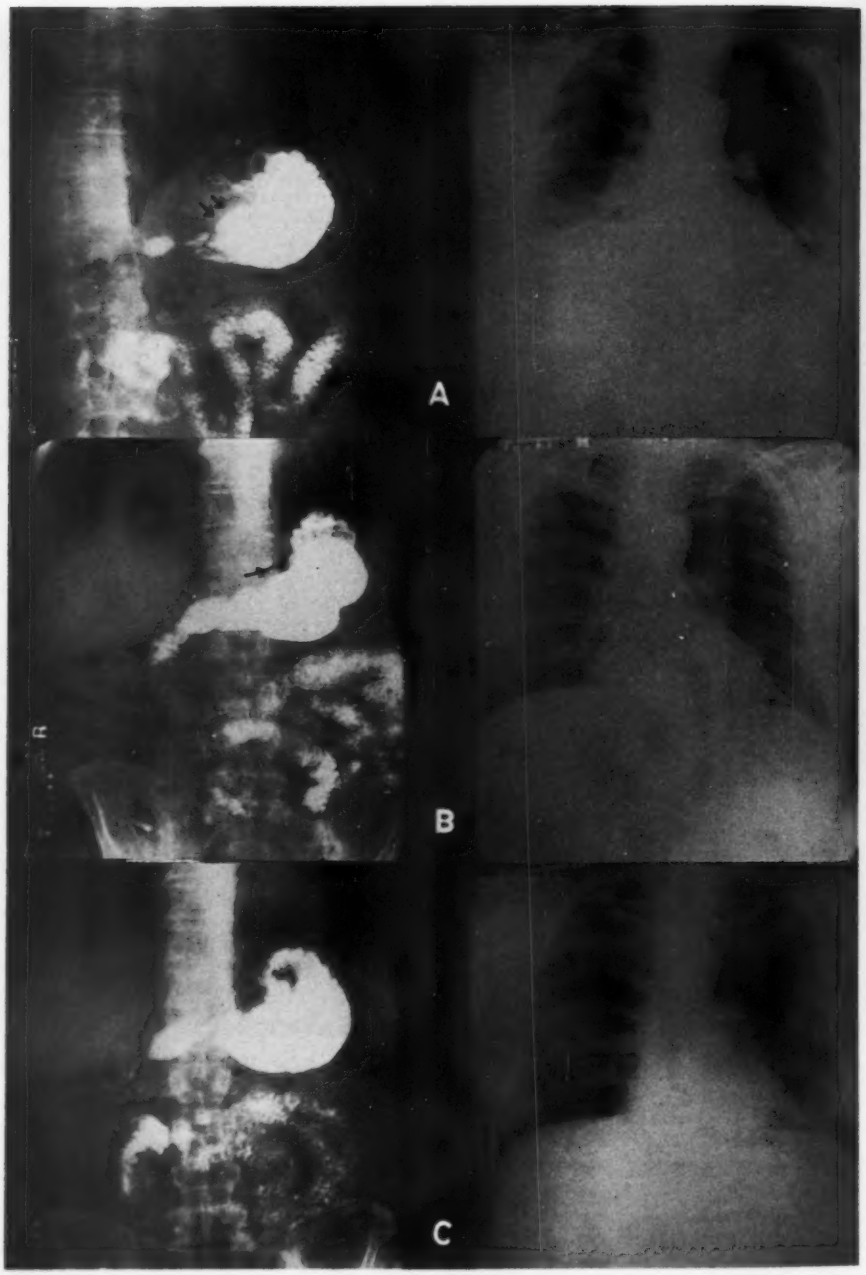

Fig. 9, A–C. Case IX. A. Feb. 28, 1956: edematous mucosa but no definite ulcer; congestive heart failure.
B. March 30, 1956: gastric ulcer on posterior wall, high on lesser curvature; cardiac condition improved roentgenographically but very little clinically.
C. April 27, 1956: ulcer almost healed; cardiac status almost normal.

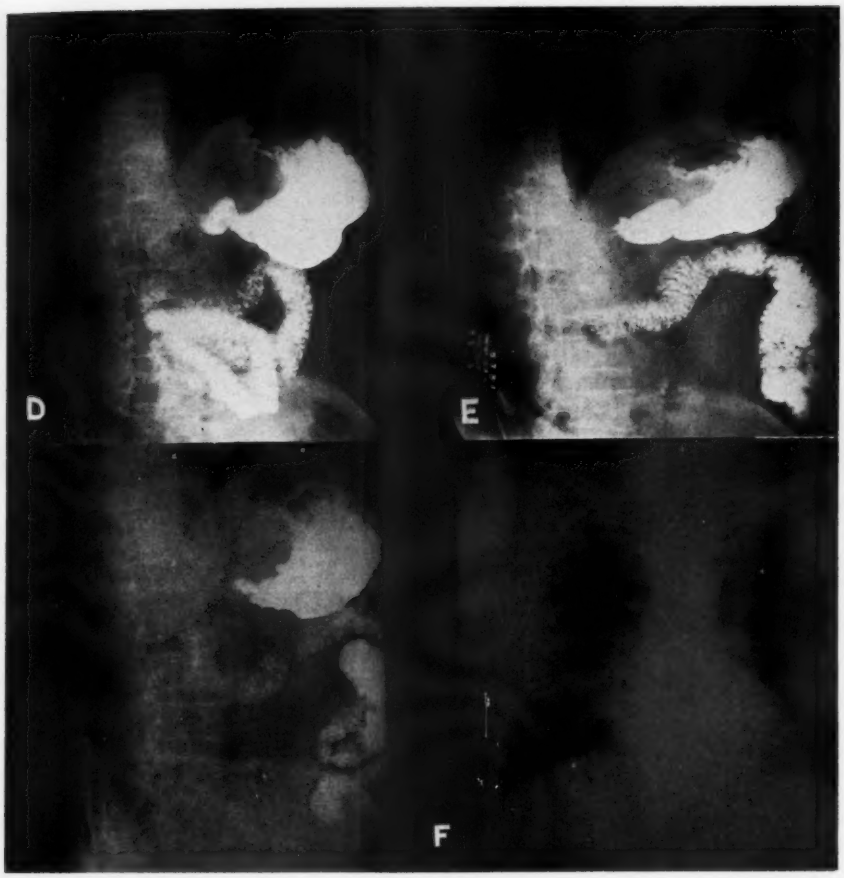

Fig. 9, D–F. D. Sept. 20, 1956: small ulcer on lesser curvature.
E. Oct. 26, 1956: no ulcer.
F. June 1957: again a large ulcer on the lesser curvature; heart enlarged. Only clinical evidence of congestion.

enlargement with auricular fibrillation. The patient was not in failure.

On a second admission, six months later (Feb. 28, 1956), primarily for chest pain, there was also complaint of vague abdominal distress and occasional vomiting. Again physical examination showed a large heart, with an apical systolic murmur and marked arrhythmia. The blood pressure was 98/70. An electrocardiogram showed auricular fibrillation and suggested myocardial damage. The blood count and urinalysis were normal. The feces were negative for occult blood. A roentgenogram of the chest demonstrated a large hypertensive heart, arteriosclerosis, and slight pulmonary congestion. The gastric mucosa was shown to be edematous but no ulcer was demonstrable (Fig. 8, A).

The patient was admitted for the third time in June 1956, with chest pain, dizziness, weakness, nausea, poor appetite, and other stomach symptoms. The electrocardiogram and the chest findings were unchanged. The red cell count was 3,870,000 and hemoglobin 12 gm. per 100 c.c. The feces were positive for occult blood (+++). A gastrointestinal series revealed a sessile ulcer on the lesser curvature (Fig. 8, B). A recheck after one month on cardiac management showed clearing of the pulmonary congestion and improvement in the ulcer.

The following case illustrates well the see-saw course of the ulcer paralleling that of the cardiac disease.

CASE IX: J. K., a white male, aged 66, entered the hospital Feb. 21, 1956, complaining of severe pain in the chest radiating to the left arm. He gave a history also of occasional heartburn.

Physical examination showed slight heart enlargement, gallop rhythm, a systolic murmur,

Fig. 10. Case X. Large sessile ulcer high on lesser curvature. Hypertensive arteriosclerotic heart; no congestion.

slight dyspnea but no cyanosis. The blood pressure was 140/80. The electrocardiogram indicated myocardial damage and coronary insufficiency. The red cell count was 3,200,000; white cell count 11,550; hemoglobin 7 gm. per 100 c.c. The feces were positive for occult blood (guaiac test ++). A chest film was indicative of congestive failure. A gastrointestinal series (Feb. 28, 1956) showed edematous mucosa but no definite ulcer. However, because of a suspicious area and the persistence of a positive guaiac test, the examination was repeated on March 30 (Fig. 9, B) revealing a large ulcer on the posterior wall of the stomach. Gastroscopy was done, with report of a chronic ulcer, "probably malignant."

With treatment of the cardiac condition, the ulcer became much smaller (Fig. 9, C) and the feces no longer showed occult blood.

The patient was discharged but while at home failed to keep to his diet and neglected his medication (digitalis). He was readmitted Sept. 20, 1956, complaining of chest pain on exertion. He had been examined elsewhere a month earlier and told that he was "O.K." The electrocardiogram was the same as before. Again a small ulcer was demonstrable on the lesser curvature (Fig. 9, D). A recheck, Oct. 26, showed no congestion and the ulcer had disappeared (Fig. 9, E) but the presence of a leiomyoma was suspected.

In June, 1957, the patient was admitted for the third time, with pain in the chest and abdomen and electrocardiographic evidence of acute coronary disease. A large ulcer was demonstrated roentgenographically (Fig. 9, F). Laboratory findings were: white cell count 5,400; hematocrit 42.5 vol. per cent; blood chemistry normal. A gastroscopy was advised, whereupon the patient, in spite of his poor condition, went A.W.O.L.

Earlier in this paper it was mentioned that during the past six months all cardiac patients received a gastrointestinal examination as soon as it was safe to move them. The following case was among these.

CASE X: H. McC., aged 59, a diabetic for fifteen years, was said to have had heart trouble for three or four years. He experienced dyspnea on exertion and complained of chest pain. He had never had any stomach trouble.

Physical examination showed a heart of normal size, with an apical systolic murmur; generalized arteriosclerosis; an enlarged liver. All laboratory data were normal. A gastric ulcer was demonstrable roentgenographically (Fig. 10). In the face of this finding, the patient insisted that he had always had a "cast iron" stomach. Before any further studies could be made, another heart attack occurred and death ensued. Permission for autopsy was not granted.

COMMENTS

In our study of 370 cardiac patients with gastrointestinal complaints, 115 were found to have gastric ulcers. Since coronary heart disease is actually an arteriosclerotic condition, it is safe to say that arteriosclerosis is an important etiological factor in the origin of gastric ulcer. This point it important because the majority of gastric ulcers occur in persons of fifty years or older, which is also the age for arteriosclerosis.

It was found that many patients, while in heart failure, show an anemia because of edema of the mucosa and probably microscopic ulcer. If heart failure continues and passes into a chronic stage or recurs frequently, demonstrable ulcers develop.

SUMMARY

1. Of 370 patients with cardiac disease having gastrointestinal symptoms, 31 per cent were found to have gastric ulcers.

2. Most of these patients had arteriosclerotic heart disease.

3. The gastric ulcers improved parallel with the improvement of the cardiac status.

4. In heart failure gastric hemorrhage is not uncommon and in chronic failure ulcers may develop.

5. No bleeding or ulcer was found in cardiac failures resulting from rheumatoid or valvular heart disease.

NOTE: We express our appreciation to F. D. Wallace, Chief of Medical Illustration Service, Veterans Administration Hospital, Lexington, Ky., for his cooperation in making the illustrations for this paper.

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SUMMARIO IN INTERLINGUA

Le Relation Inter Disfallimento Cardiac E Ulcere Gastric In Le Gruppo De Etates Plus Avantiate

Il pare exister un definite relation inter morbo cardiac in patientes de etate plus avantiate—specialmente inter arteriosclerotic morbo cardiac (incluse morbo coronari)—e ulceres gastric. Inter 1.187 patientes cardiac, excluse illes con morbo rheumatic e valvular, il se trovava 370 con symptomas gastrointestinal de severitate sufficientemente sever pro justificar un examine a radios X. In 115 de istes (i.e., in 31 pro cento), le presentia de ulceres gastric esseva demonstrate. Le etate medie in iste ultime gruppo esseva sexanta-tres annos.

In multe patientes in disfallimento cardiac, anemia esseva presente con edema del mucosa gastric. Quando le disfallimento deveniva chronic o recurreva frequentemente, multes del patientes disveloppava ulcere demonstrabile. Le ulceres associate con le morbo cardiac manifestava melioration e mesmo dispareva con le responsa al therapia del condition cardiac.

Splenic Vein Thrombosis

Three Cases[1]

WILLIAM MOLNAR, M.D., FRANK A. RIEBEL, M.D., and KENNETH R. McCORMACK, M.D.

SPLENIC VEIN thrombosis is rarely diagnosed with certainty prior to surgery or autopsy. From 1944 to 1955, at the Ohio State University Hospital, 1 example was found among 358 splenectomies done for hematologic disorders. In the several large series of splenoportograms reported in the literature since 1952, only single instances of thrombosis of the splenic vein have been demonstrated. In 1956, 3 cases were diagnosed by percutaneous splenoportography among 36 splenectomies done at Ohio State University Hospital for hematologic conditions. This increased discovery rate may be related to the introduction of percutaneous splenoportography, first described by Dreyer and Baudtz-Olsen (10) in 1952 and employed in this institution since 1954.

In these 3 cases the venous collaterals of the portal system are strikingly diverse; in 2 of them the unusual appearance gave rise to problems in interpretation. The purpose of this presentation is to call attention to the great variation in anastomotic patterns in splenic vein thrombosis, and to present 1 case in which the enormously dilated esophageal plexus simulated mediastinal tumor on the plain chest film. Our review of the literature up to July 1, 1957, failed to produce a similar recorded example.

CASE HISTORIES

CASE I: J. S., a 61-year-old male, was admitted to University Hospital on Feb. 26, 1956, with a history of melena three or four weeks previously. One and one-half years prior to admission he had hematemesis and melena. X-ray examination elsewhere reportedly demonstrated an ulcer. There had been no recent weight loss. In the 1930's x-ray therapy had been given for splenomegaly.

The patient appeared to be in no acute distress. The spleen, which was palpable 5 fingers' breadth below the left costal margin, was nontender and mobile. There were bilateral reducible inguinal hernias.

Laboratory findings were as follows: proteinuria 20 mg. per cent; stool, guaiac-negative; hemoglobin 12.4 gm.; red blood cells 5,780,000; white cells, 6,250, with 70 per cent neutrophils, 24 per cent lymphocytes, 4 per cent eosinophils, 2 per cent basophils; Van den Bergh reaction 0.4 mg. per cent direct, 1.5 total; Bromsulphalein retention 2.4 per cent; blood urea nitrogen 14 mg. per cent; fasting blood sugar 126 mg. per cent. Gastric analysis and inorganic and alkaline phosphatase determinations were normal. Blood calcium was 9.7 mg. per cent, cholesterol 100 mg. per cent, and platelets 1,800,000 (normal values, Dameshek, 500,000 to 900,000).

A bone marrow aspiration showed panhyperplasia, presumably associated with blood loss, and only a mild degree of hypersplenism. The increased platelet count was probably due to the hyperplastic bone marrow after excessive blood loss. During the second admission, in March 1956, esophagoscopy showed esophagitis and small varices.

The splenoportogram, with serial films taken at 3-second intervals (Figs. 1, 2, and 3), showed gradual filling of the greatly dilated and tortuous left gastroepiploic vein, which had anastomosed with the right gastroepiploic vein and drained the blood supply of the spleen *via* the superior mesenteric vein to the portal vein. It is interesting to note on the first of the serial films that the early part of the left gastroepiploic vein is directed to the diaphragm and the descending tortuous segment of the same vein is visualized at the lateral aspect of the spleen on the second serial film. The horizontal portion of the gastroepiploic channel is extremely tortuous and we see the superior pancreaticoduodenal vein as it joins the proximal portion of the right gastroepiploic vein. In addition to these channels, the short gastric vein seems to be anastomosed to the elongated and tortuous coronary vein. The inferior mesenteric vein is not demonstrated. It was probably obstructed by the same process which involved the splenic vein. There was minimal reflux of contrast medium into the superior mesenteric vein. The completely obstructed segment of the splenic vein was 10 cm. long and extended into the hilus of the spleen.

The excised spleen showed adenofibrosis and weighed 1,016 gm. Biopsy of the liver showed normal liver substance. There was no evidence of a

[1] From the Department of Radiology, The Ohio State University Health Center, Columbus, Ohio. Accepted, for publication in December 1957.

Fig. 1. Case I: First serial film, showing no flow of contrast material through the splenic vein. The early portion of the markedly dilated left gastroepiploic vein is visualized as it ascends toward the diaphragm and then descends along the lateral aspect of the spleen. The tortuous and dilated short gastric veins are outlined following reflux of the contrast material.

Fig. 2. Case I: Second film, taken approximately three seconds after the first, demonstrating the anastomosis between the left and right gastroepiploic veins. Part of the contrast material flows through the short gastric-coronary anastomosis to the portal vein.

Fig. 3. Case I: The proximal part of the gastroepiploic system is filled and the connection through the superior mesenteric vein to the portal vein is demonstrated.

pathologic process in the adjacent organs at surgery, and the case therefore belongs to the group of idiopathic primary splenic vein thromboses.

CASE II: E. B., a 53-year-old white male, was admitted on July 10, 1956, with a history of tarry stools for three weeks, and a two-year history of easy bruising. He had been hospitalized one year before and again six months later for melena. Three weeks prior to this admission, severe gastrointestinal bleeding had been controlled by an esophageal balloon. There had been a 35-pound weight loss in the previous year and the patient had received 22 pints of blood in the three weeks prior to entering the hospital. Multiple small skin lipomata or fibromata were palpated over the body; the spleen was 6 fingers' breadth below the costal margin.

The hemoglobin was 9.5 gm.; the red cell count 3,500,000, with 6.2 per cent reticulocytes; platelet count 426,000 (Dameshek); hematocrit 28; white cell count 3,500, with 77 per cent polymorphonuclears, 14 per cent lymphocytes, and 7 per cent monocytes; prothrombin time 65 per cent of normal; blood sugar 108 mg. per cent; blood urea nitrogen 31 mg. per cent. Stools were positive for blood by the guaiac test.

An upper gastrointestinal series showed large esophageal and gastric varices. There was a calcific mass in the left upper abdomen. A splenogram (Fig. 4) was made, and a splenectomy was performed on the same day. The calcific mass was found to be in the pancreas. At surgery, splenic vein thrombosis, splenomegaly, and esophageal varices were found. The liver was biopsied following splenectomy. The pathologist's findings were adenofibrosis of the spleen, fibrous perisplenitis, and slight portal cirrhosis.

The large, partially calcified, inflammatory mass found in the pancreas indicates that the splenic vein thrombosis was probably secondary to the chronic pancreatitis. The hematologic findings were characteristic for hypersplenism with pansplenic hematopenia. The distal part of the splenic vein was completely obstructed at a point corresponding to the location of the calcified mass in the pancreas, and the portal vein was demonstrated by the contrast material flowing *via* the perisplenic and retroperitoneal veins into the portal system. In reviewing the literature, we learn that this anastomotic channel is frequently prominent in pancreatic lesions.

CASE III: R. M., a 29-year-old white female, entered University Hospital on May 24, 1956, with an eight-year history of known splenomegaly and vague abdominal discomfort. She had experienced

Fig. 4. Case II: The amorphous calcification in the left side of the epigastrium seen on the preliminary film is overlapped by the contrast material within the tortuous retroperitoneal veins. The distal portion of the splenic vein is obstructed and there is a second partial obstruction of the portal system in front of L-I, close to the orifice of the superior mesenteric vein.

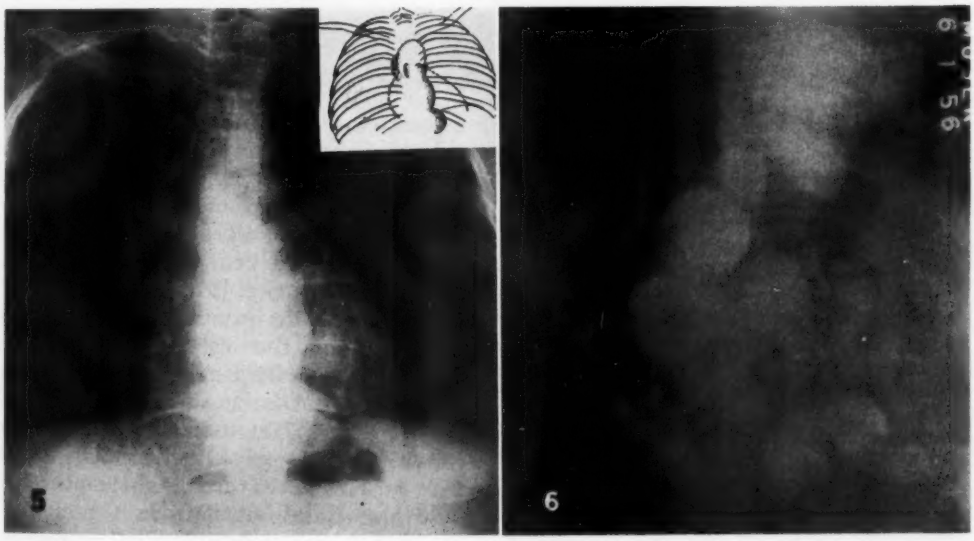

Fig. 5. Case III: Bucky postero-anterior chest film taken prior to surgery, showing the lobulated mediastinal mass on both sides of the spine.

Fig. 6. Case III: Splenoportogram showing complete obstruction of the splenic vein. The contrast material flows through a single markedly dilated and tortuous short gastric vein to the esophageal plexus, which explains the lobulated mediastinal mass appearing on the chest film. The portal vein failed to fill even eight seconds later, as demonstrated on serial films.

Fig. 7. Case III: Chest film taken one year following splenectomy, showing complete disappearance of the mediastinal soft-tissue masses seen in Fig. 5. There is also a diminution in transverse cardiac diameter as compared with the presurgical films.

episodes of hemoptysis and hematemesis within the preceding four years, for which she received ten blood transfusions. The spleen was palpable down to the iliac crest.

Laboratory findings were as follows: hemoglobin 12.8 gm.; red cell count 3,740,000, with 98,000 platelets (Dameshek count); white cells 3,100 with 58 per cent polymorphonuclears, 27 per cent eosinophils, and 16 per cent lymphocytes; prothrombin time 44 per cent of normal; urinalysis normal; Van den Bergh reaction 1.0 mg. per cent direct and 2.2 total; thymol turbidity 20; cephalin flocculation 2+; serum protein 6.4 gm. with A/G ratio of 3.7/2.7; blood urea nitrogen 14 mg. per cent; Bromsulphalein retention 13 per cent. Alkaline phosphatase was 2.2 units.

The chest film showed a lobulated soft-tissue mass mainly along the left side of the spine, extending from the diaphragm to the upper pole of the right hilus (Fig. 5). The plain film of the abdomen showed an annular retrogastric calcification in the epigastrium which was attributed to a calcified splenic artery aneurysm or to a pancreatic cyst. A splenogram showed complete obstruction of the splenic vein at the level of the calcified epigastric mass (Fig. 6).

A splenectomy was done on June 8, 1956, and surgery confirmed the findings of splenoportography. The splenic vein was obstructed at the level of a large aneurysm of the splenic artery and the tortuous dilated short gastric vein leading from the splenic vein to the mediastinum was visualized.

The spleen weighed 910 gm. Microscopic sections showed fibroadenosis, distended sinusoids, and hemorrhagic infarcted areas throughout. The splenic vein was filled with organized thrombus. There was an aneurysm of the splenic artery. Liver biopsy showed scattered pigment, but no evidence of cirrhotic changes.

When the patient was restudied in June, 1957, there was no evidence of a mediastinal mass (Fig. 7) and the esophageal varices were no longer demonstrable by barium studies (Fig. 8).

In this case hematologic diagnosis of hypersplenism and pansplenic hematopenia was made before demonstration of the splenic vein thrombosis by splenoportography. On the radiologic examinations of the chest and abdomen we failed to recognize the connection between the epigastric annular calcification with enlarged spleen and the lobulated mediastinal mass. The relationship between the mediastinal and abdominal findings became evident only after the splenoportography. This showed that all the venous blood of the greatly enlarged spleen was directed to the esophageal varices and finally to the azygos system, through a single markedly dilated short gastric vein, secondary to the obstruction of the splenic vein which was probably caused by the aneurysm of the splenic artery.

DISCUSSION

Thrombosis of the splenic vein may be associated with a variety of lesions, among them compression or invasion of the splenic vein by carcinoma of the pancreas (7, 21), carcinoma of the stomach and esophagus (31), or an enlarged lymph node (5), pressure by benign lesions such as chronic pancreatitis (21, 34), retrogastric hematoma due to trauma (22, 28), or large aneurysm of the splenic artery (23). Thrombosis is a frequent sequel to splenectomy (26) and is occasionally seen after gastrectomy (31). Certain hematologic conditions like polycythemia (25), or in very rare instances thrombocythemia (25), may also cause splenic vein thrombosis. Omphalitis in children may result in splenoportal stenosis and congestive splenomegaly (17). Just where Banti's disease fits into the clinical picture of portal hypertension is a much debated question. There is considerable doubt today regarding this

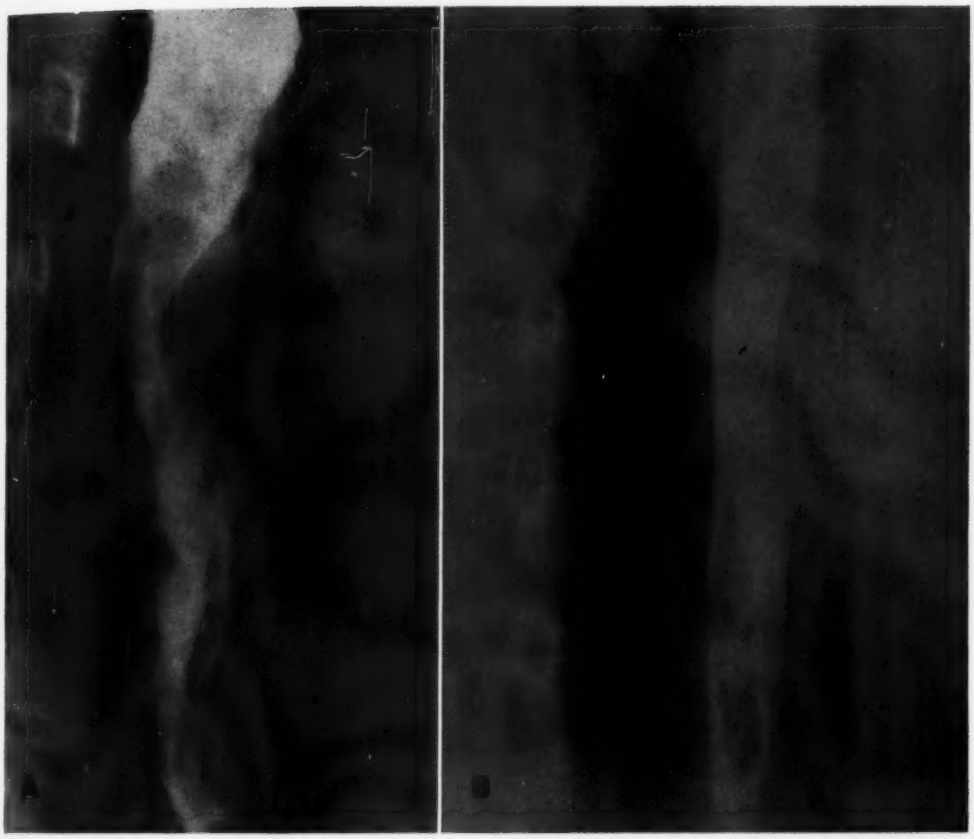

Fig. 8. Case III: A. Esophagus before splenectomy. B. One year after surgery: disappearance of the huge esophageal varices.

disease as a separate entity (28, 34), and the findings described by Banti may be only the results of splenic vein obstruction, regardless of cause.

The long history of repeated episodes of painless gastrointestinal hemorrhage associated frequently with easy bruising is suggestive of portal hypertension. The presence of an enlarged spleen with mixed or pancytopenia, normal or close-to-normal liver function tests, or even negative liver biopsy, are suggestive of extrahepatic obstruction of the portal system, which should be investigated by splenoportography.

Following splenic vein thrombosis collateral circulation may develop between (*a*) the short gastric veins and esophageal veins, (*b*) short gastric veins and coronary vein, (*c*) perisplenic veins, retroperitoneal veins, and portal vein, (*d*) left and right gastroepiploic veins, (*e*) inferior and superior mesenteric veins *via* the right and left colic veins, and (*f*) between perisplenic and left renal veins. The radiologic appearance of the obstructed portal system will vary greatly with the site of the obstruction and will be influenced by the existing anatomical variations (14, 16, 28, 30) in the portal system before thrombosis. The anatomical variations may explain, at least in part, the great difference in the anastomotic patterns of the three cases reported here, although the site of the obstruction is almost identical.

SUMMARY

Three cases of splenic vein obstruction

are reported, with three different anastomotic patterns. In one case a lobulated mediastinal mass was visualized on the chest films, formed by the greatly dilated para-esophageal plexus of veins. This was demonstrated by splenoportography and proved at surgery. No similar case has been reported in literature to our knowledge. It is suggested, therefore, that the possibility of dilated esophageal varices should be included in the differential diagnosis of a lobulated mediastinal mass in the presence of a large spleen.

NOTE: Since this material was collected, two more proved cases of splenic vein thrombosis have been demonstrated in this department *via* percutaneous splenoportography.

We are deeply indebted to Dr. Edwin H. Ellison, Professor of Surgery, Ohio State University Health Center, for the surgical statistics and the surgical proof of the cases reported herein. We are also grateful to Dr. Bertha Bouroncle, Associate Professor of Medicine, Ohio State University Health Center, for review of the hematological findings in these cases.

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SUMMARIO IN INTERLINGUA

Thrombose De Vena Splenic: Tres Casos

Post thrombose de vena splenic, circulation collateral pote disveloppar se inter (1) le curte venas gastric e le venas esophagee, (2) le curte venas gastric e le vena coronari, (3) le venas perisplenic, le venas retroperitonee, e le vena portal, (4) le sinistre e le dextere venas gastro-epiploic, (5) le inferior e le superior venas mesenteric, via le dextere e le sinistre venas colic, e (6) le venas perisplenic e sinistro-renal. Le apparentia radiologic del obstruite systema portal varia grandemente con le sito del obstruction e es influentiate per variationes anatomic existente in le systema portal ante le occurrentia del thrombose.

Es presentate tres casos de thrombose de vena splenic con tres differente configurationes anastomotic in consequentia, al minus in parte, de variationes anatomic. In un caso un lobulate massa mediastinal esseva visualisate in un roentgenogramma thoracic, formate per le grandemente dilatate plexo para-esophagee de venas. Le natura del massa esseva demonstrate per splenoportographia e confirmate al operation. Es suggerite que le possibilitate de dilatate varices esophagee es includite in le diagnose differential de un lobulate massa mediastinal incontrate in le presentia de un allargamento del splen.

Diastematomyelia in Adults[1]

WM. B. SEAMAN, M.D., and HENRY G. SCHWARTZ, M.D.

DIASTEMATOMYELIA IS a congenital malformation in which a band of fibrous or bony tissue extends dorsoventrally through the spinal canal and between the portions of either a partially duplicated or split spinal cord. According to Bremer (2), this represents one manifestation of a persistent accessory neurenteric canal or dorsal intestinal fistula. These fistulas, which in the embryo extend from the enteric cavity to the neural groove, may persist and present clinically as tubular tracts reaching from some portion of the gastrointestinal tract to the skin (7, 9). Others may form cysts and be mistaken for anterior meningoceles or branchial cysts (2). More commonly the fistula disappears, but according to Bremer its former presence may be manifested by: increased breadth of the vertebral bodies; a circular or oval defect extending through the vertebral bodies; development of the vertebra in two halves, which later fuse to form a median bony or cartilaginous spur projecting into the spinal canal and transfixing the spinal cord; a fibrous cord formed by a remaining fragment of the fistula, attached to an inconspicuous midline cutaneous dimple.

Bremer's explanation is that the two halves of the spinal cord, which have been separated in a widened spinal canal by the bony or cartilaginous spur, do not attempt to reunite after the fistula disappears but are invested by meninges and continue their development either as the two lateral halves of a spinal cord (diastematomyelia) or as a pair of malformed whole cords (diplomyelia). He feels that these indications of a former median cleft both in the spinal cord and vertebra offer definite proof of the earlier presence of an accessory dorsal intestinal fistula.

This malformation was first described in 1837, and in 1940 Herren and Edwards (6) were able to collect 42 cases from the literature. It was not until 1950 that clinical interest was aroused by the report of Neuhauser, Wittenborg and Dehlinger (13). They described 12 cases, in 10 of which a correct preoperative diagnosis was made. Since their report several additional examples have appeared in the medical literature (1, 3, 4, 8, 15, 16). All of the patients in whom a diagnosis is reported to have been made during life have been children, with the exception of a twenty-year-old female described by Hamby (5). We are presenting here 2 examples in adults aged twenty and thirty-nine years. In the older patient diastematomyelia was correctly diagnosed preoperatively.

CASE I: E. B. H., a 39-year-old white male, sought medical advice because of numbness in the medial aspect of both thighs for the past six months, occasionally associated with paresthesia. The patient was a pharmacist, who worked in a standing position eleven hours daily, seven days a week, with only slight difficulty. For the past two years he had noticed occasional sharp pain in the lower lumbar region, which he did not attribute to trauma. He stated that atrophy of the right leg and moderate kyphosis had been present since childhood. The paresthesias involved both lower extremities. Difficulty in walking was denied, but for six weeks there had been some difficulty in arising from a sitting position or in standing too long.

Examination disclosed a moderate kyphoscoliosis with some atrophy of the right leg and thigh. Deep tendon reflexes were normal except for absence of the left ankle jerk. Minimal hypesthesia was present over the entire right lower extremity up to the inguinal region. Examination of the cerebrospinal fluid was negative. Catheterization of the bladder following urination disclosed retention of only 12 c.c.

Roentgen examination of the dorsal spine revealed a moderate kyphosis in the middorsal region and a minimal scoliosis, with the apex of the curve to the right at the level of T-12. The spinal canal was markedly widened from the second to the eleventh dorsal vertebra (Fig. 1). The pedicles were intact, with no evidence of erosion. There was lack of segmentation of the first eight dorsal vertebrae. The vertebral bodies were diminished in both the

[1] From the Department of Radiology (W. B. S.) and the Division of Neurological Surgery (H. G. S.), Washington University School of Medicine, St. Louis, Mo. Accepted for publication in November 1957.

Fig. 1. Case I. Anteroposterior and lateral roentgenograms of the upper thoracic spine showing kyphosis, incomplete segmentation, and widened spinal canal containing linear streak of increased density representing a central bony spur.

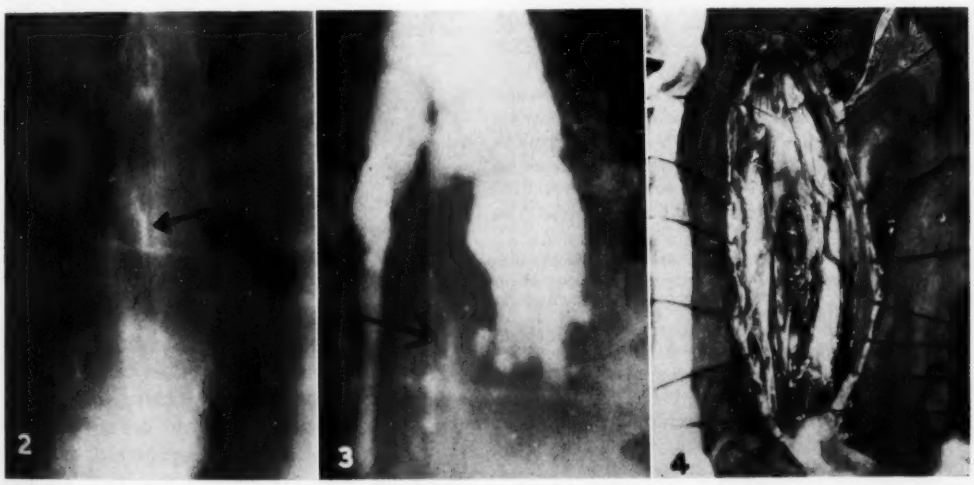

Fig. 2. Case I. Anteroposterior laminagram demonstrating the intraspinal location of the bony spicule.
Fig. 3. Case I. Myelogram demonstrating a large, oval radiolucent filling defect with central calcified spur.
Fig. 4. Case I. Photograph taken at time of surgery, showing the midline bony spur separating a duplicated spinal cord. The spur was continuous with the spinous process of T-5.

vertical and anteroposterior dimensions but were much wider than normal. In the frontal projection a midline linear streak of calcific density was noted in the area of the widest portion of the spinal canal. This could not be definitely identified in the lateral projection. Laminagraphic studies of the dorsal spine confirmed the impression that this streak of increased density was within the lumen of the spinal canal (Fig. 2). A roentgen diagnosis of diastematomyelia was made and myelography was advised.

During the myelographic examination an oval radiolucent filling defect was observed containing a

dense central linear streak (Fig. 3). The opaque material also outlined a widened spinal cord and a diverticulum located posteriorly to the spinal cord shadow. It was thought that the myelographic findings confirmed the initial impression of diastematomyelia and that the diverticulum possibly represented an abortive attempt at duplication of the meninges.

A total laminectomy of the first eight thoracic vertebrae was performed by Dr. H. G. Schwartz. In the middorsal region the laminae were fused. The spinous process of the fifth dorsal vertebra was continuous with a large bony spur measuring 1.5 × 0.5 cm. and extending down through the dura (Fig. 4). The spinal cord was found to be completely split from the level of the second to the seventh dorsal vertebra, and the bony spur passed through the cleft cord. A similar bony spur extended from the spine of the fourth dorsal vertebra but not through the dura. The large bony spur at T-5, was removed from between the two halves of the cord and the incision was closed. The subsequent course was satisfactory. Hypesthesia disappeared and the left ankle jerk returned. The patient has continued to work regularly without any complaint.

CASE II:[2] L. B., a 20-year-old student nurse, complained of severe pain in the low back of five days duration, which was more severe on the left side. She described it as resembling menstrual cramps. On the fifth day the pain began to radiate down the entire lower extremity and became so severe that she was admitted to the hospital.

Tenderness over the fourth and fifth lumbar vertebrae and spasm and tenderness of the paraspinal muscles on the left were present. The left knee jerk was absent. There was hypesthesia to pin prick on the lateral aspect of the left leg and in the lower third of the left thigh. The left calf was noted to be slightly smaller than the right.

On the following day the left ankle jerk disappeared and a positive Lasegue sign developed on the left. The subsequent day the pain had increased to such a degree that it was not relieved by morphine. The patient was unable to flex or extend the knee, although the range of motion at the ankle and hip were normal. On the tenth day her condition was unchanged except for the return of the left knee jerk. Roentgen examination of the lumbar spine and pelvis at another hospital was said to be negative, although the subsequent myelogram demonstrated a slight increase in the width of the third and fourth vertebral bodies and a widening of the spinal canal at the level of the third and fourth lumbar vertebrae. The pedicles were normal. The myelogram showed the opaque medium to flow around a central nonopaque filling defect (Fig. 5).

At laminectomy a fibrocartilaginous septum arising from the posterior surfaces of the second and third lumbar vertebral bodies was found, extending through the cauda equina and meninges.

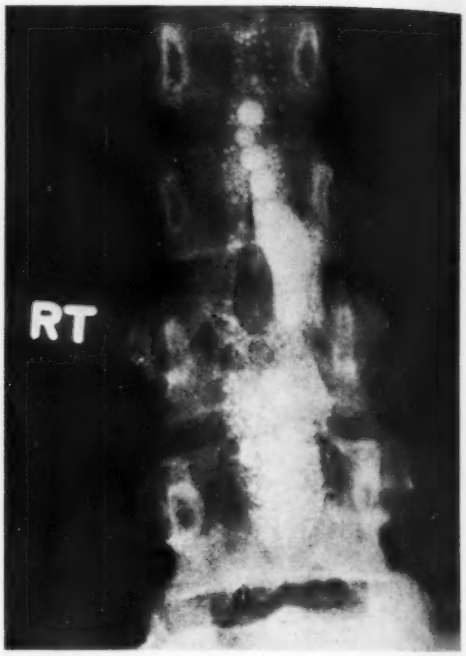

Fig. 5. Case II. Myelogram demonstrating midline radiolucent filling defect. Note absence of calcification within it and the slight widening of the spinal canal.

DISCUSSION

The occurrence of diastematomyelia in adults is unusual, most of the clinical cases having been described in children. However, 11 (26 per cent) of the reported 42 cases collected by Herren and Edwards were in persons sixteen years old and over, including 2 patients over forty and 1 who was seventy-six. Hamby described this condition in a twenty-year-old female. Both of our patients presented clinical problems of a relatively acute nature despite the congenital origin of their difficulty. Thus it seems that neither the age of the patient nor the acuteness of the symptoms exclude diastematomyelia as a possible cause of low back pain.

Because of the atypical clinical picture which may be associated with diastematomyelia, the responsibility for the diagnosis

[2] This case is included through the courtesy of Dr. H. R. McCarroll.

usually rests upon the radiologist. Abnormalities of the vertebrae are important clues to the presence of this condition and practically all of the recently reported cases in which the diagnosis was made preoperatively were associated with anomalies of the spine. The vertebral bodies may exhibit an increase in the transverse diameter but a decrease in height and in the anteroposterior diameter. Several bodies may be unsegmented or have narrow intervertebral spaces. Kyphosis and scoliosis are frequent. Hemivertebra, abnormal fusion of the lamina, and spina bifida may occur. Although the spinal canal is usually widened, the pedicles are not narrowed, in contrast to the findings observed with intraspinal tumors. It must be emphasized that the spinal abnormalities may be extremely minimal, as in Case II or, according to Herren and Edwards, the appearance may even be normal.

The midline bony spicule is the most characteristic finding but unfortunately is frequently absent. When present, it is usually best seen in the frontal projection. Laminagraphy is a useful technic for confirmation of its presence and its intraspinal position (4). When none of the above findings is present, the diagnosis can be made only by the myelographic demonstration of a round or elongated filling defect in the central portion of the opaque column of contrast substance.

SUMMARY

1. Two examples of diastematomyelia occurring in adults are described.

2. Each patient presented with symptoms of a relatively acute nature.

3. The roentgen features of this anomaly are discussed.

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SUMMARIO IN INTERLINGUA

Diastematomyelia in Adultos

Diastematomyelia es un malformation congenite in que un banda de histo fibrose o ossee se extende dorsoventralmente per le canal del spina dorsal e passa inter le portiones de un partialmente duplicate o findite medulla vertebral. Le condition es incontrate plus communmente in juveniles, e omne le patientes—con un exception—in qui le establimento del diagnose durante le vita es reportate in le litteratura pertineva al mentionate gruppo de etate.

Duo casos es reportate in adultos de 39

e 20 annos de etate. In le plus vetule del duo, roentgenodiagnose esseva facite ante le operation.

Le constatation le plus characteristic es le spicula ossee del linea central, sed isto es frequentemente absente. Quando illo es presente, illo se visualisa le melio generalmente in le projection frontal. Laminagraphia es utile como technica pro confirmar su presentia e su position intraspinal. In le absentia de altere constatationes, le diagnose pote esser facite solmente per myelographia le qual demonstra un rotunde o elongate defecto de replenamento in le portion central del columna opac de substantia de contrasto.

Aortic Valvulography and Ascending Aortography[1]

SIDNEY W. NELSON, M.D.,[2] WILLIAM MOLNAR, M.D.,[2] KARL P. KLASSEN, M.D.[3] and JOSEPH M. RYAN, M.D.[4]

IN OUR INSTITUTION (Ohio State University) there has been an increasing awareness of the fact that patients who undergo mitral commissurotomy for mitral stenosis occasionally do very poorly if there is a co-existing aortic valve lesion. Moreover, it is recognized that in a small number of patients it is quite difficult, if not impossible, to differentiate clinically between the diastolic murmurs of aortic insufficiency and pulmonary valvular insufficiency (Graham Steell murmur). It is the purpose of this paper to report on the development of a method of thoracic aortography which is well suited for the evaluation of aortic valvular function (aortic "valvulography") in that relatively small group of patients with confusing diastolic murmurs. It is hoped that the information gained regarding the function of the aortic valves will be useful in future analyses of the results of mitral valvulotomy. The method to be described is also of value in the study of lesions of the ascending aorta and coronary arteries, structures which are not consistently well visualized by other methods of thoracic aortography.

It is our opinion that the accurate differential diagnosis between the murmurs of pulmonary valvular insufficiency and aortic valvular insufficiency is important if mitral commissurotomy is being considered, since patients with pulmonary valvular insufficiency (Graham Steell murmur) due to mitral stenosis should, and usually do, benefit greatly from the operation, whereas this expected improvement is sometimes not seen in patients with coexisting aortic insufficiency. The only previous mention of the unsatisfactory postoperative clinical course following mitral commissurotomy in patients with coexisting aortic valve disease is that by Uricchio and Likoff (1). In January 1957, they reported 3 cases with aortic stenosis and insufficiency in which "mitral commissurotomy was succeeded by unmistakable evidence of an increase in the severity of the coexisting uncorrected aortic valve defects," with progressively increasing heart failure and death.

The problem of accurate differential diagnosis in those patients with a diastolic murmur which could be due to either aortic insufficiency or pulmonic valvular insufficiency seemed amenable to a radiological solution, and we accordingly started our investigations in 1955. It was apparent that it would be necessary to inject contrast material near the aortic valve region in concentrations adequate for accurate radiographic evaluation of pathological regurgitation through the aortic valves into the left ventricle. Furthermore, since all previously described methods of injection against the rapidly moving blood flow in the aorta necessitated high pressures, it was postulated that the resultant rapidly moving jet of contrast material directed against the valve orifice might result in factitious regurgitation through normal valves. It was felt necessary, therefore, to approach the problem experimentally in dogs, in order to clarify the importance of injection pressure, direction of flow of the jet of injected contrast material, and location of the catheter opening in relation to the valve orifice. It was hoped that a successful method of studying aortic valve competence would also be the best method of

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[1] From The Ohio State University Health Center, Columbus, Ohio. Presented as an exhibit at the Forty-third Annual Meeting of the Radiological Society of North America, Chicago, Nov. 17–22, 1957.
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visualizing the ascending aorta and coronary arteries, which were not consistently well visualized with other technics of thoracic aortography.

DEVELOPMENT OF A METHOD

In planning our approach, we reviewed our own experience and that of others in the field of thoracic aortography. Figure 1 is a diagrammatic outline of the development of that procedure. Nuvoli (2) in 1936 injected sodium iodide into the aorta in 2 patients by inserting the needle through the right side of the sternum. Radner (3) in 1945 performed trans-sternal thoracic aortography in an attempt to study the coronary arteries, and Meneses Hoyos and Gomez del Campo (4) in 1948 reported on a method of inserting the needle into the aorta through the second left anterior intercostal space parasternally. Euler (5) in 1949 described direct aortic puncture through the esophagus at esophagoscopy. It is understandable that we were reluctant to use these direct puncture methods, because of the uncertainty as to the exact location of the needle tip, with the possibility of aortic trauma, pneumomediastinum, pneumothorax, and inadvertent extravascular injection of large amounts of contrast material.

Castellanos and Pereiras (6) in 1939 first reported on their method of thoracic aortography accomplished by injecting contrast material by cannula into the left brachial artery. They originated this "counter-current" method of injecting against the direction of arterial bloodflow, and have had much experience with it in their pioneering work in this field. Stephens (7) in 1948, Burford, Carson, and Scott (8) in 1949, and Freeman *et al.* (9) in 1950 reported their experiences with "counter-current" injections of the left common carotid. These "counter-current" methods are highly successful in visualizing the aortic arch and descending aorta but do not afford consistently good visualization of the aortic valve, coronary arteries, and ascending aorta because the contrast material reaching the aortic arch from a peripheral artery tends to move with the arterial flow into the descending aorta, rather than against the flow into the ascending aorta. We therefore decided against the "counter-current" technic for our study.

In 1948, Radner (10) developed the technic of passing a catheter into the aorta *via* the right radial artery. Jönsson, Brodén, Hanson, and Karnell (11, 12) further modified this method and used it extensively with excellent results, finding its greatest usefulness in the diagnosis of lesions of the distal aortic arch, particularly patent ductus arteriosus and coarctation of the aorta. The insertion of small catheters into the aorta *via* the small peripheral arteries is often difficult (13), due to arteriospasm and misdirection of the catheter into the great vessels arising from the aorta, or into the descending aorta rather than into the ascending aorta. It is also difficult to inject adequate amounts of contrast material rapidly through a small-lumen catheter, the tip of which unfortunately may change position during injection made under high pressure. Furthermore, there is some reason to fear a tiny rapidly moving jet of contrast material injected under high pressure (14), because of the possible traumatic effect upon the wall of the aorta and aortic valves. For the foregoing reasons, the small catheter methods were not chosen for our investigation.

Jönsson (15) in 1949 reported on a double-cannula method of entering the aortic arch *via* the common carotid arteries. He obtained good aortograms but subsequently abandoned the method because of difficulty in positioning the tip of the cannula, the greatest danger being the possible penetration of the inferior wall of the aortic arch opposite the origin of the innominate or left common carotid artery, with possible extravascular injection. Marion and Papillon (16) in 1950 described a similar method of passing a trocar into the aorta *via* the left carotid. In a few cases when they used the right carotid they obtained good visualization of the ascending aorta. The uncertainty of these

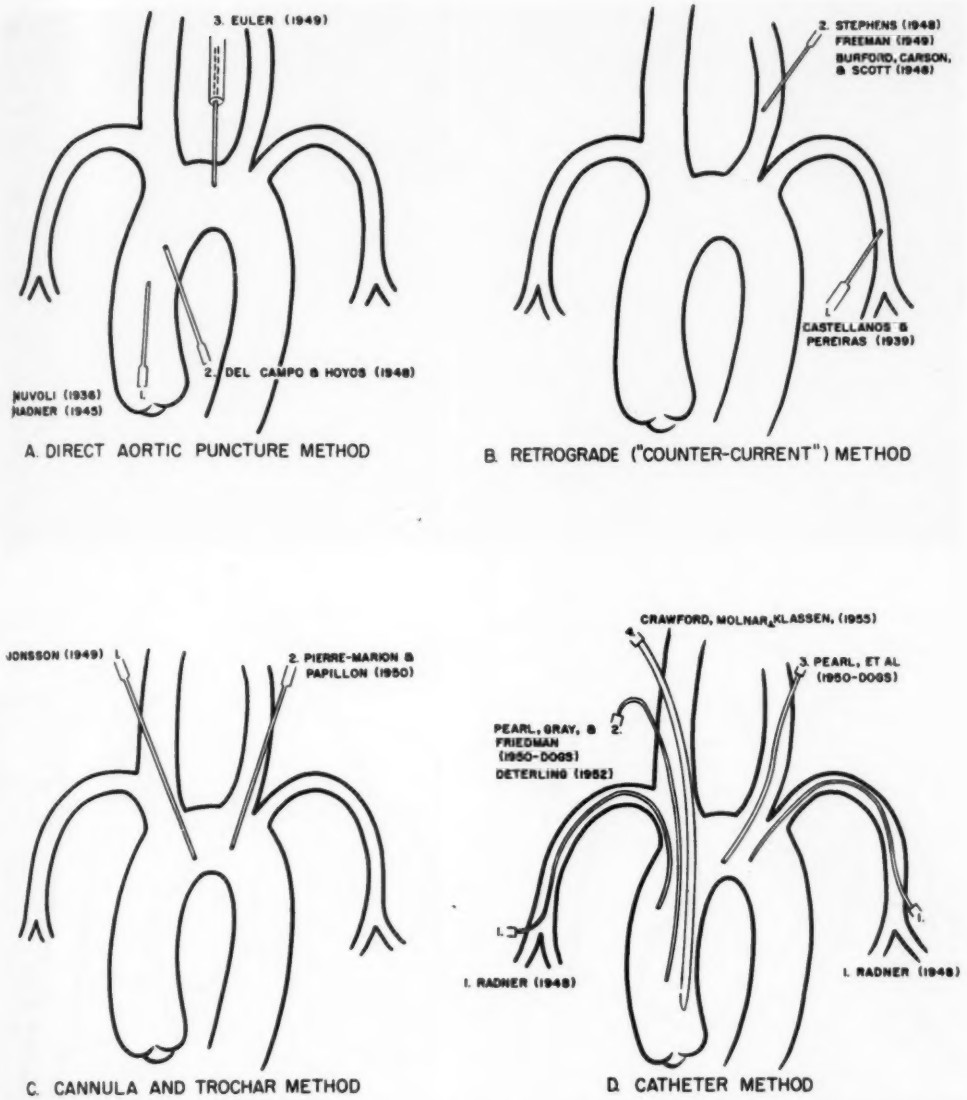


Fig. 1. Various methods of thoracic aortography. The authors' method is illustrated in "D" (Crawford, Molnar, and Klassen), showing the closed-end, side-opening catheter inserted through the right common carotid into the ascending aorta in such a way that the catheter opening is about 3 cm. proximal to the aortic valve.

methods precluded our investigating them as a solution to our problem.

Pearl, Gray, and Friedman (17) in 1950 used a slightly larger catheter than those employed by other authors. They catheterized right and left carotid arteries in dogs and were able to see clearly the aortic valves, coronary arteries, and ascending aorta. They did not use the method in man.

Crawford, Molnar, and Klassen (18) of our own institution in 1956 reported on the use of a flexible large-bore catheter introduced into the aortic arch *via* the right common carotid after surgical exposure. We believed that a modification of this method

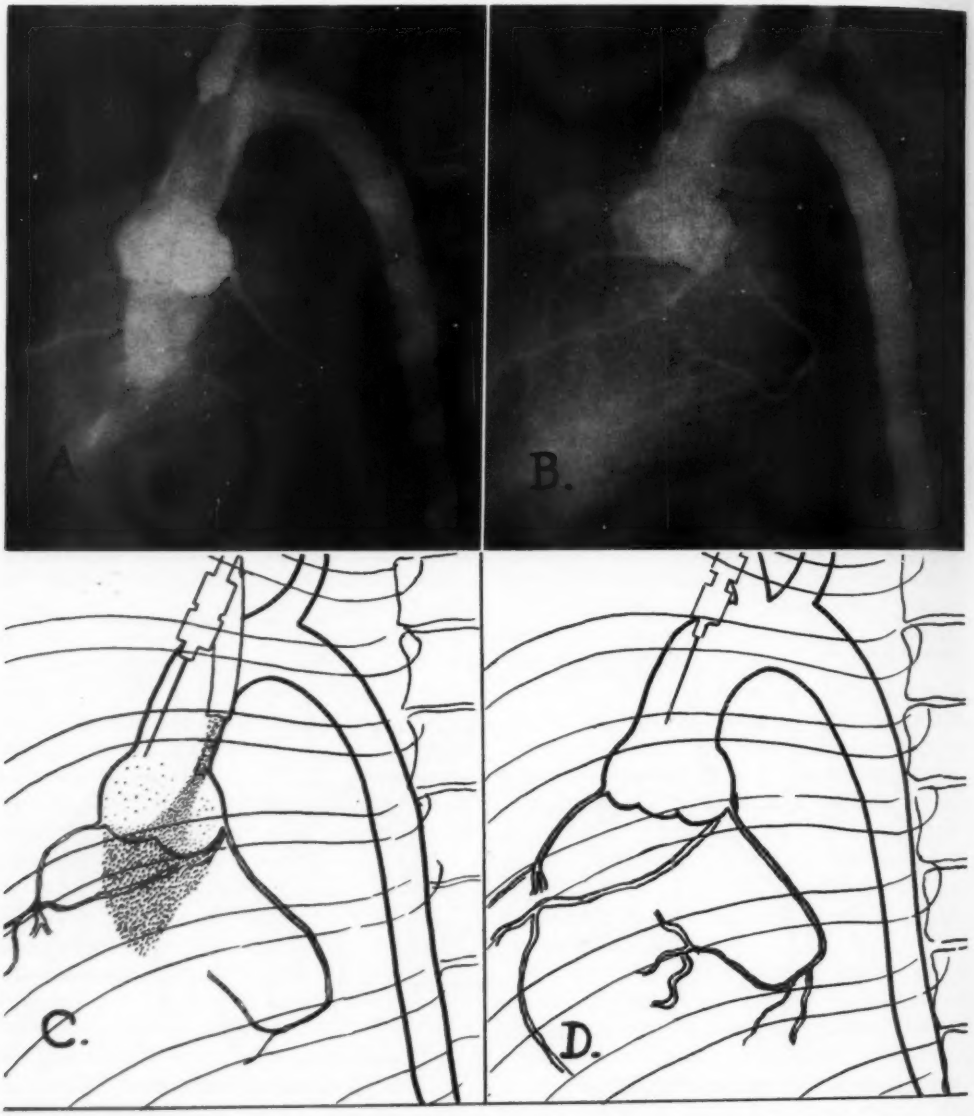


Fig. 2. The forceful forward jet of contrast material injected through an open-end catheter can produce evidence of aortic regurgitation in dogs without evidence of valvular disease at autopsy.

A. The collection of contrast material below the valve during injection is due to the direct jet of contrast material against the aortic valve. Note the good visualization of the coronary arteries. Needle inserted into aortic arch anterior to innominate artery is for purpose of measuring intra-aortic blood pressure during injection.

B. Two seconds later, after injection has ceased: no evidence of aortic insufficiency. Note the good visualization of the coronary arteries.

C and D. Line drawings of A and B, respectively. Shaded areas indicate the jet of contrast material above the valve and regurgitation of contrast material below the valve.

(which we were using routinely for retrograde aortography) so as to control fluoroscopically the passage of the catheter tip into the region of the aortic valves, would allow us to inject safely enough contrast material into the region we wished to investigate.

It was first necessary to evaluate the

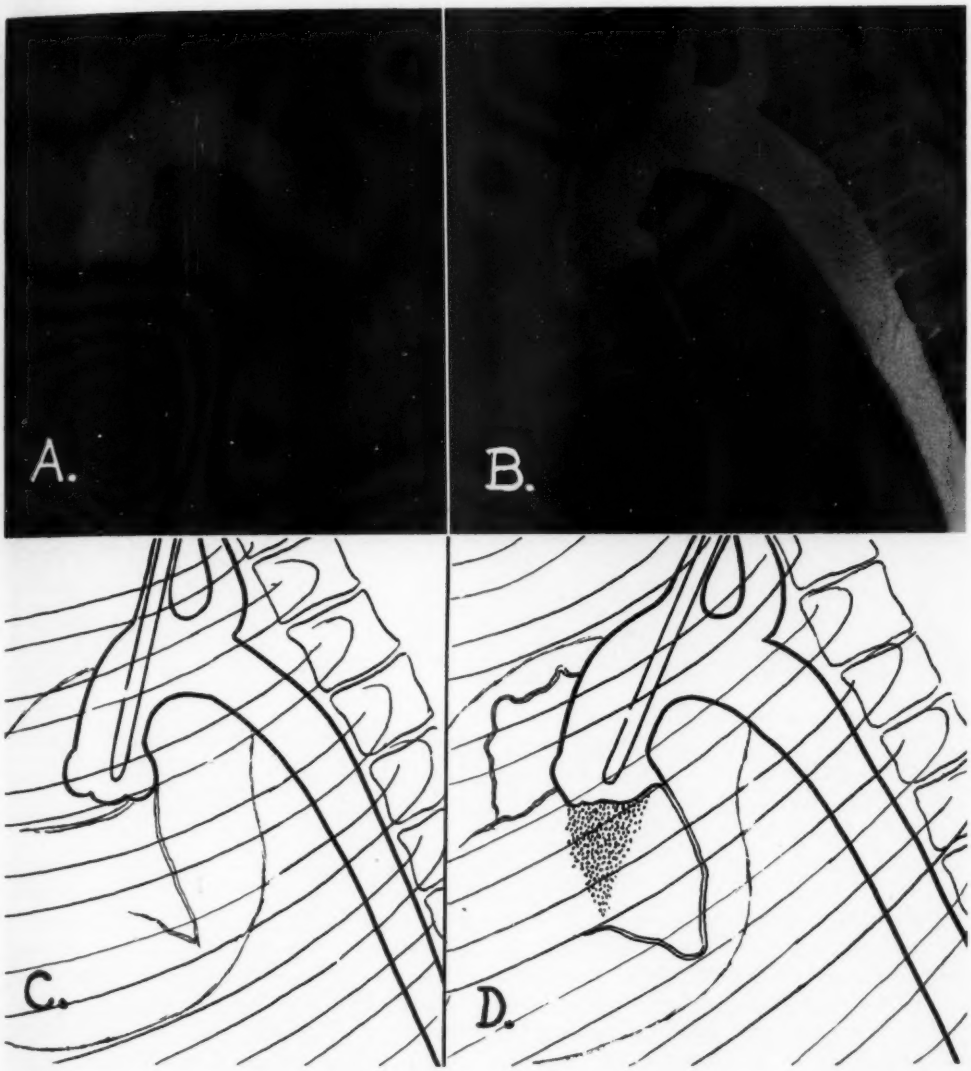


Fig. 3. A. Aortogram made during injection of contrast material through closed-end, side-opening catheter, showing normal aortic valve and coronary arteries without evidence of regurgitation. Needle inserted into aorta anterior to innominate artery measures intra-aortic pressure during injection of contrast material.

B. Subsequent aortogram following intentional perforation of aortic valve with metallic probe, showing contrast material below the aortic valve, indicating aortic regurgitation. Note the good visualization of the coronary arteries.

C and D. Line drawings of A and B respectively. Shaded area below valve indicates regurgitated contrast material.

radiographic signs of valvular competence (or incompetence) experimentally on dogs before attempting studies in man. It was postulated that even a normal valve might allow "regurgitation" of contrast material if a rapidly moving jet was directed at the center of the open valve orifice. It was further assumed that, if the injection were made at high pressure too close to a normal valve, we might see evidence of regurgitation even if the jet of contrast material was not directed at the center of the open

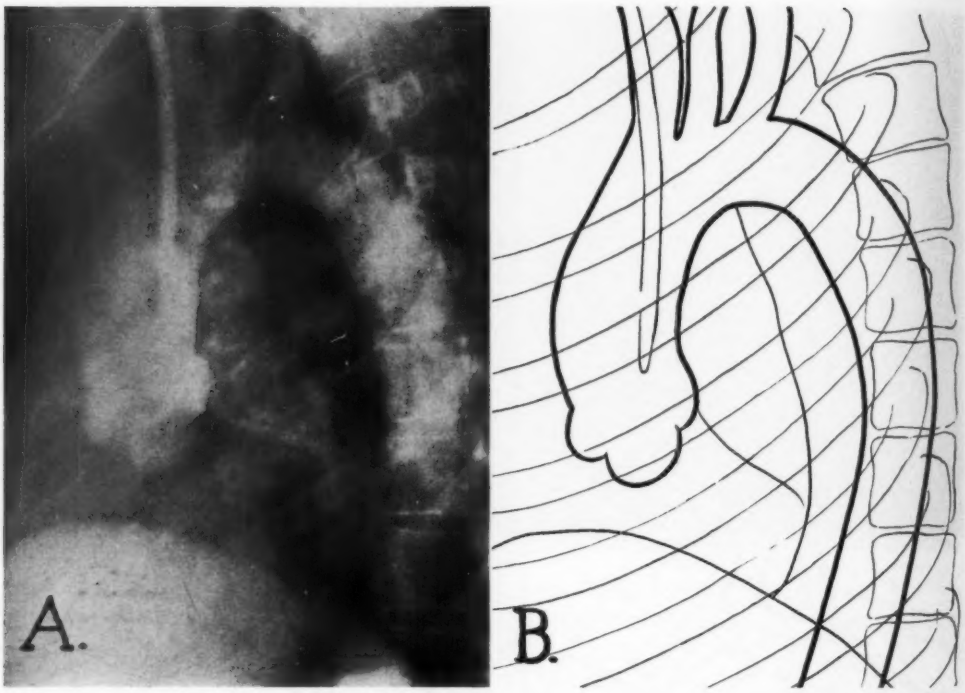


Fig. 4. A 30-year-old white female with rheumatic heart disease experienced exertional dyspnea, and substernal pain radiating into both arms. A grade-2 diastolic murmur was heard along the left sternal border. A grade-3 low rumbling diastolic murmur with pre-systolic accentuation was present in the apical region. There were no thrills. P_2 was louder than A_2. Cardiac catheterization was not completely successful because the catheter could not be advanced beyond the right atrium. Cardiac output increased from 5.5 liters per minute at rest to 9.6 liters per minute after eight minutes of exercise at a rate of 2,000 foot pounds per minute. The loud diastolic murmur made it desirable to differentiate aortic insufficiency and pulmonary valvular insufficiency.
A. Aortogram shows normal aortic valve with no evidence of aortic insufficiency.
B. Line drawing of A.

orifice. Our experiments upon 14 dogs proved that injection of contrast material through open-end catheters near the aortic valve orifice would produce evidence of "aortic regurgitation" in animals proved at autopsy to have normal valves (Fig. 2). The regurgitation consistently occurred during systole, while the valves were open and the forceful direct jet of contrast medium penetrated through the blood stream. We therefore abandoned the use of an open-end catheter and used a side-opening, closed-end catheter. The tip of this we tried to position 2 to 3 cm. cephalic to the valves, because in the course of a few injections regurgitation was seen if the tip of the catheter was in the aortic sinus or between the valve leaflets. This technic precluded our obtaining false radiographic evidence of aortic insufficiency and gave consistent visualization of the valves, coronary arteries, and entire aortic arch (Fig. 3, A). Inasmuch as none of the dogs used in our experiments had lesions of the aortic valves, we wondered if this method would show radiographic evidence of pathological aortic insufficiency when it actually existed. Therefore, the aortic valves of some of the normal dogs without radiographic evidence of aortic regurgitation were intentionally perforated by metallic directors, following which the injection of the contrast material by the method outlined above consistently showed evidence of aortic insufficiency (Fig. 3, B).

TECHNIC USED ON PATIENTS

Through a small skin incision the right

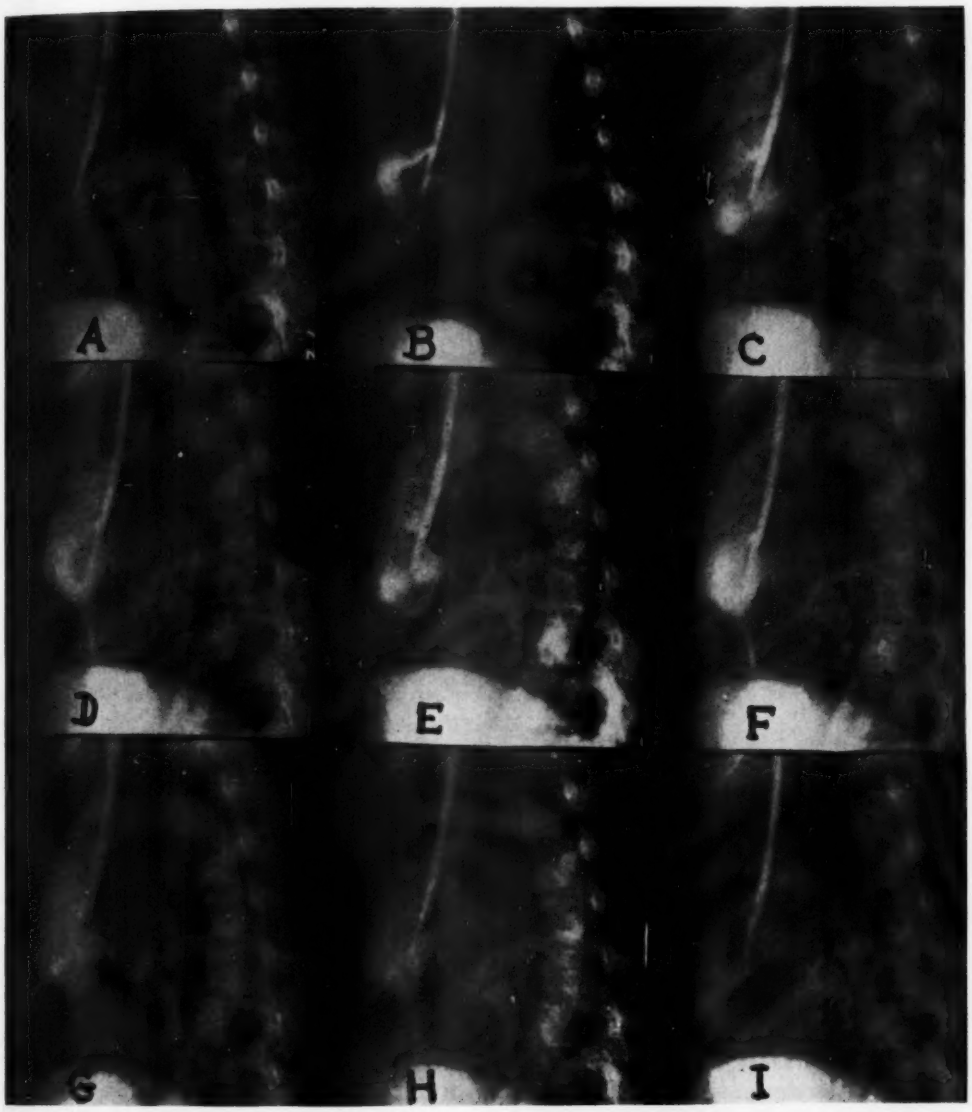


Fig. 5. Example of minimal, although definite, radiographic evidence of aortic insufficiency as demonstrated in complete series of exposures made at 0.65-second intervals. Note small streaks of contrast material which has regurgitated through the aortic valve into the left ventricle, as shown in D, F, and H, during diastole. During the systolic phase of the cycle (C, E, and G) the subaortic streaks of contrast material are no longer visible, due to the ejection of the small amounts of opacified blood into the densely opacified ascending aorta. Between each of the exposures in the above illustration there was one complete cardiac cycle, during which no x-ray exposures were made because of the 0.65 second exposure interval used. The patient was a 26-year-old female who had a confusing diastolic murmur along the left sternal border. Clarification of the murmur was desired before mitral commissurotomy. Note fairly good filling of coronary arteries.

common carotid artery is exposed surgically and two cigarette drains are drawn beneath it, one proximal and one distal to the intended point of incision. Traction on the drains then delivers the artery into the wound, following which a tiny incision is made and the specially constructed 14F tapered silk, closed-end, side-opening cath-

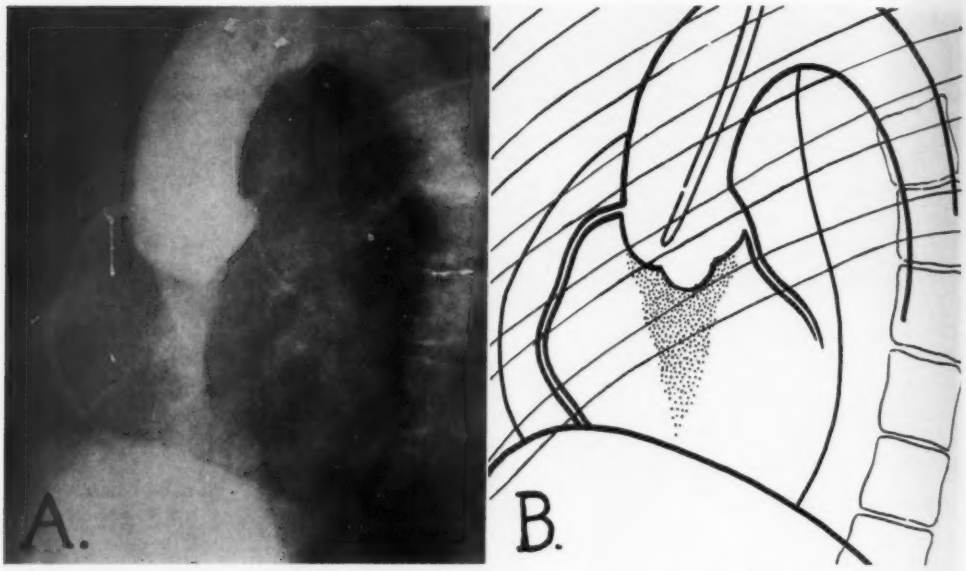


Fig. 6. A 35-year-old white female gave a long history of rheumatic heart disease. During the two years prior to admission she had progressively increasing exertional dyspnea and many episodes of hemoptysis. Aortic valvulography was done because of a loud diastolic murmur along the left sternal border.

A. Aortogram showing contrast material below the aortic valve, indicating a moderate degree of aortic insufficiency.

B. Line drawing of A, with shaded area indicating contrast material which has regurgitated through an insufficient aortic valve.

eter[5] is advanced through the incision into the aortic arch under fluoroscopic control. The tip is easily directed into the ascending aorta, where, as it approaches the aortic valve region, it will begin to exhibit a side-to-side fluttering motion. As soon as the catheter is in the desired position, 30 c.c. of 90 per cent Hypaque is injected by means of an automatic injection device (5 kg. pressure per square centimeter) in two to four seconds, with electrically controlled exposures starting simultaneously with the beginning of the injection and continuing for six seconds. The injection can also be done manually in three or four seconds with a Robb-Steinberg needle, the first exposure being made when half of the contrast material has been introduced.

During the injection, traction is made upon the cigarette drain on the cephalic side of the injection site in the right carotid, and the left carotid is compressed manually in order to diminish the amount of contrast material that reaches the brain. Broman and Olsson (19, 20) demonstrated a definite relationship between the time-concentration factor and organic brain damage due to the contrast material passing the blood-brain barrier. To preclude further the danger of cerebral damage as much as possible, each carotid is compressed continuously for twelve minutes on the day before the aortogram is obtained, in order to detect any deleterious cerebral effects from the relative anoxia so produced. The entire aortographic procedure, from the time the carotid incision is made until the catheter is withdrawn and the incision closed with silk, is eight to eleven minutes, although in some of our earliest efforts the procedure lasted as long as twenty minutes.

[5] Catheters used were made by C. R. Bard, Inc., Summit, N. J.

CLINICAL RESULTS

This technic was used on patients with mitral stenosis and diastolic murmurs which could not be definitely localized to the aortic or pulmonary valve by clinical

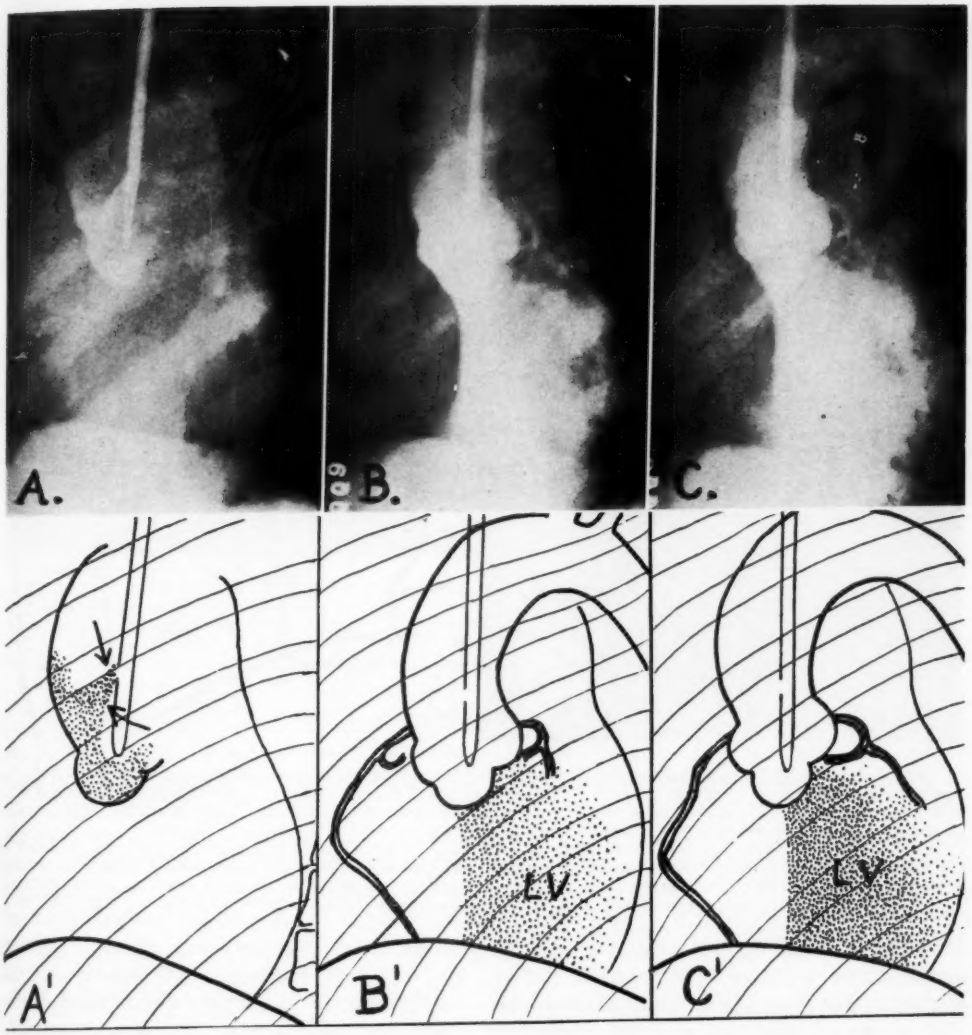


Fig. 7. A 44-year-old white female had typical clinical findings of predominant mitral stenosis and insufficiency. Cardiac catheterization showed marked pulmonary hypertension. A loud diastolic murmur along the left sternal border raised the question of aortic insufficiency or the Graham Steell murmur of pulmonary valvular insufficiency.

A. First exposure made after injection. The jet of contrast material emerging from the side of the closed-end, side-opening catheter is directed against the side of the aorta above the valve region rather than directly against the valve, which might occur if an end-opening catheter were used.

B and C. Later exposures during the injection show an advanced degree of aortic insufficiency. A′, B′, and C′. Line drawings of A, B, and C, respectively, the shaded areas indicating the regurgitated contrast material on the left ventricular side of the aortic valve. Arrows in A′ show the jet of contrast material emerging from the side-opening catheter.

methods. In those patients with no radiographic evidence of aortic insufficiency on the aortogram (Fig. 4) we do not believe that the diastolic murmur is due to that cause, but rather to pulmonary valvular insufficiency (Graham Steell murmur) coincident with the high pressure in the lesser circulation as a result of the severe degree of mitral stenosis. During the successive aortographic exposures, a minimal degree of aortic insufficiency is manifested by transitory visualization of small streaks of

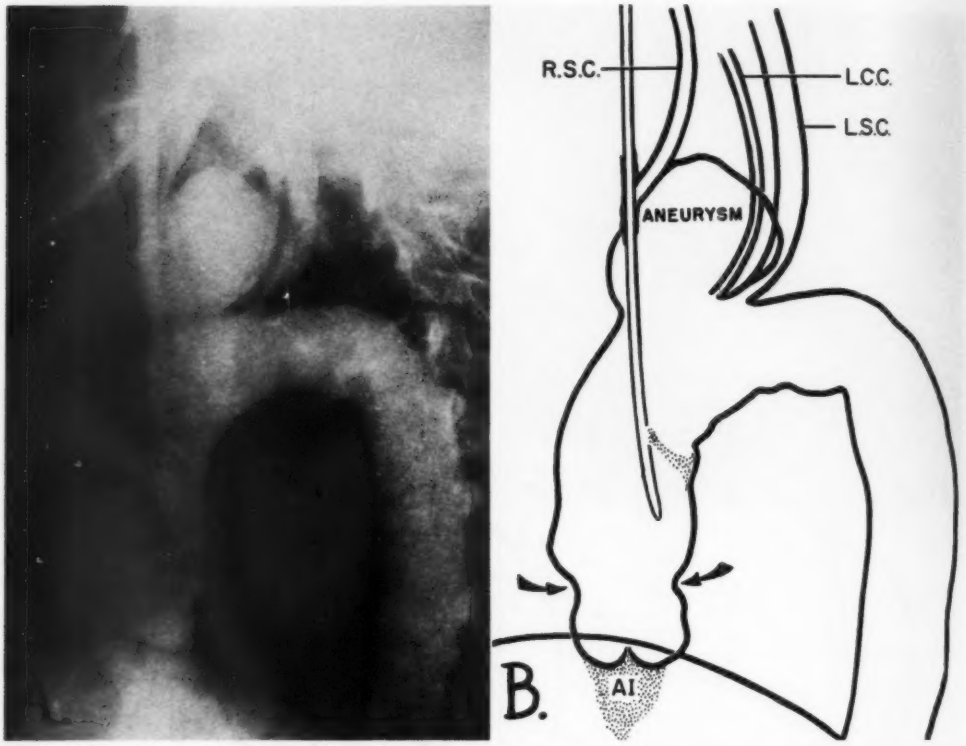


Fig. 8. A. Aortogram showing aneurysm arising from the top of the aortic arch between the origin of the innominate and left common carotid arteries. The aneurysm actually involved the origin of the innominate artery, which is compressed and not shown on the film, although the catheter passes through it. It is very helpful to the surgeon to know preoperatively the exact relationship of the aneurysm to the great vessels.

B. Line drawing of A. Arrows point to the normal-caliber supravalvular region of the aorta, above which is the dilated region so often involved in syphilitic aortitis. Shaded areas below the valve indicate contrast material regurgitated through the incompetent aortic valve. Shaded area to the right of the lower end of the catheter represents the jet of contrast material emerging from the side-opening of the catheter near the end of the injection.

contrast material regurgitating through the aortic valve into the left ventricle during diastole (Fig. 5). These small subvalvular collections of contrast material disappear during systole, as the subvalvular blood is forced into the aorta to mix with the contrast material being injected through the catheter. In a moderate degree of aortic insufficiency (Fig. 6) the subvalvular collection of contrast material is more prominent during diastole and does not tend to disappear completely during systole, whereas in advanced cases the concentration of contrast material in the left ventricle becomes greater with each diastolic phase, because of the increasingly large amounts remaining at the end of each successive systolic phase of the cycle (Fig. 7).

In those patients in whom there is definite radiographic evidence of aortic insufficiency of moderate or advanced degree, we believe that this might contraindicate mitral valvulotomy, or at least be of help in making a more accurate prognosis. However, future analyses of our end-results will have to be made before the significance of coexisting aortic insufficiency can be determined.

Other aortic valvular lesions can be demonstrated by this method. Figure 8 is the aortogram of a patient with a superior mediastinal mass which was shown to be an aneurysm arising between the innominate and left common carotid. The ascending aorta above the valve ring is deformed, apparently due to chronic syphili-

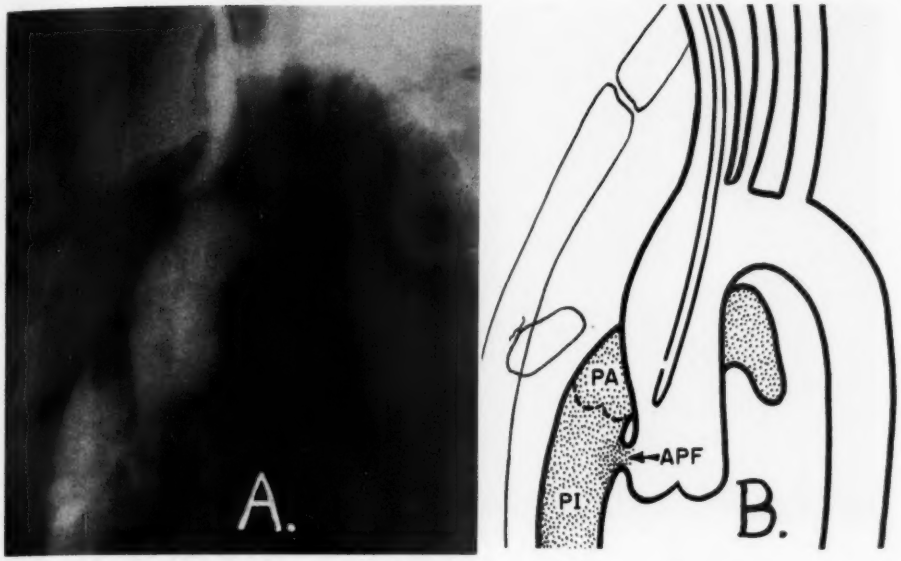


Fig. 9. A. Aortogram showing almost simultaneous visualization of aorta, infundibulum of the right ventricle, and pulmonary artery, thus indicating a left-to-right shunt. The shunt can be seen between the aorta and infundibulum of the right ventricle just distal to the right anterior aortic cusp.

B. Line drawing of A. Arrow points to aortic pulmonary fistula (APF) located below the level of the pulmonary valve. Shaded areas represent the infundibulum (PI) and pulmonary artery (PA). Dotted line indicates approximate location of pulmonary valve.

tic aortitis. There is also evidence of aortic insufficiency. This is a spectacular example of how clearly the important aortic manifestations of syphilis can be demonstrated by this method. In another patient, with chronic rheumatic heart disease, ill-defined radiolucent areas could be seen on the aortic valve cusps on two different aortographic examinations made three months apart. These we believe were due to vegetations or marked valve thickening and scarring. This added complication possibly contributed to the advanced degree of aortic insufficiency in this instance (Fig. 7).

Aortopulmonary fistulas can be easily demonstrated, as shown in Figure 9, the aortogram of a patient who had been stabbed in the anterior chest, following which generalized cardiomegaly, dyspnea, and cyanosis developed. A pulmonary artery-aortic fistula was suspected clinically, but exploratory thoracotomy at another institution failed to discover the location of the lesion. The transcarotid aortogram demonstrated the fistula between the right coronary sinus and the infundibulum of the right ventricle. The authors know of no other similar occurrence and are aware of only one reported case (21) in which a communication between the aorta and the pulmonary artery has been demonstrated radiographically.

Particularly confusing cases of heart disease can be clarified by this method, which, in one patient with cyanotic heart disease, showed with spectacular clarity a patent ductus arteriosus, aortic insufficiency, and pulmonary valvular insufficiency (Fig. 10). The pulmonary valvular insufficiency was probably due to pulmonary hypertension. This case again demonstrates the extensive cardiovascular physiologic information which can be gained in a few moments by this method of aortography.

Although our technic of thoracic aortography was devised primarily for study of the aortic valve region, the coronary arteries, and the ascending aorta, in our hands it has proved to be the most efficient method of thoracic aortography in general.

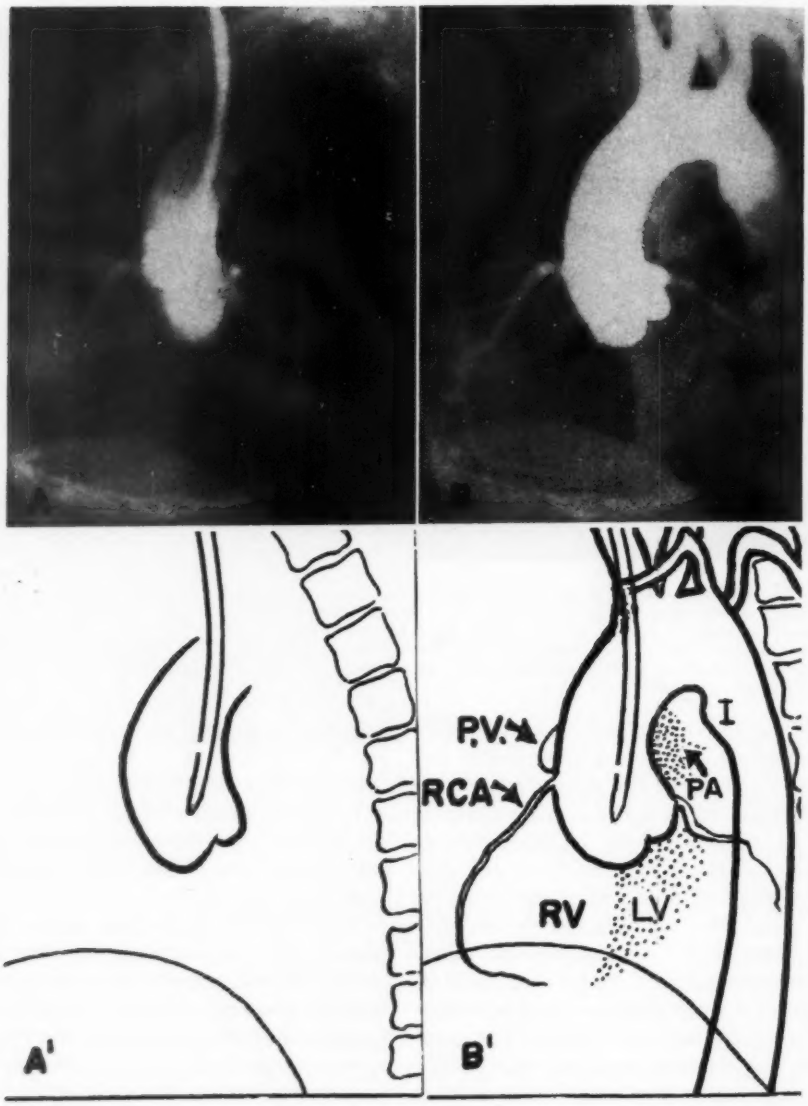
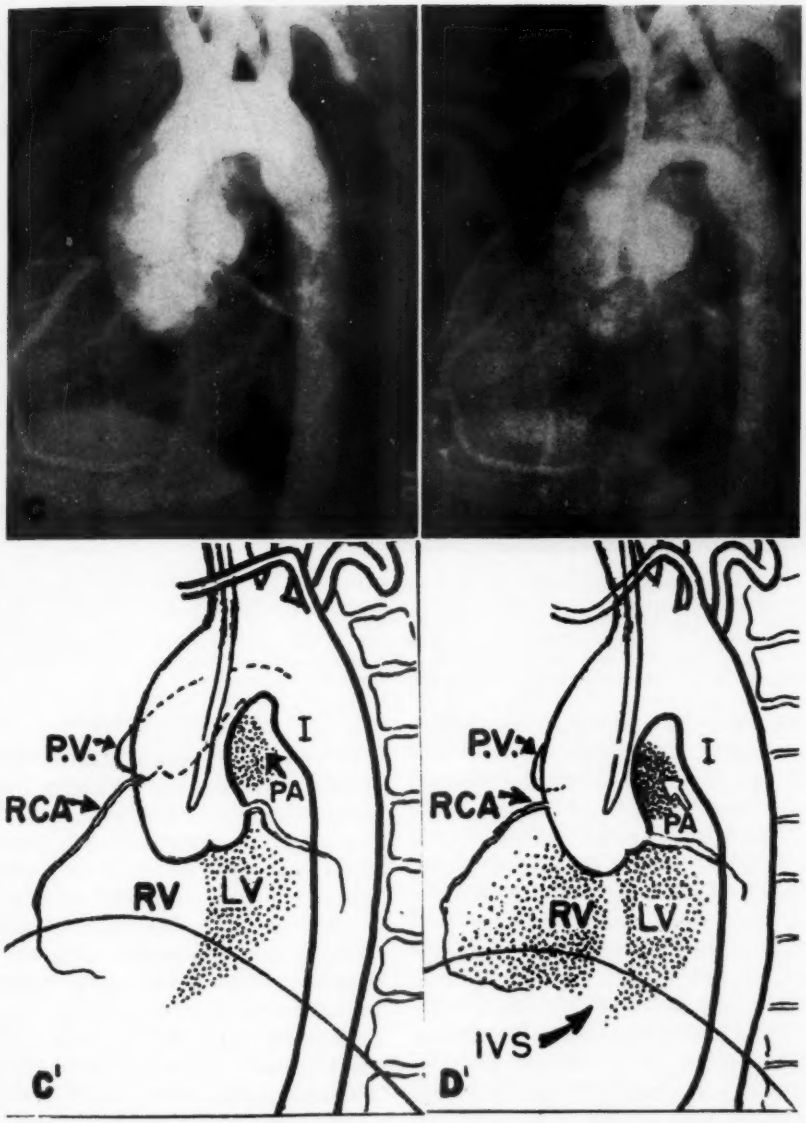


Fig. 10. Right transcarotid aortogram of a 23-year-old white female with a history of heart disease since the age of five years. The patient had a pericardectomy at the age of fourteen for calcific pericarditis. Onset of cyanosis was noted at age of twenty-two. At the time of the aortogram the patient was moderately cyanotic at rest, with clubbing of fingers and toes and systolic and diastolic murmurs over the entire precordium. There was a marked diminution in the arterial oxygen saturation of the lower extremities (38 per cent) as compared to arterial oxygen saturation in the upper extremities (70 per cent), thus indicating a right-to-left shunt between the subclavian and femoral arteries.

A. View made 0.65 second after beginning of injection, showing filling of proximal aorta. (If a fistula existed between the pulmonary artery and ascending aorta, the pulmonary artery should be visualized at this stage.) Note calcified pericardium.

B. View made 1.3 seconds after A, showing localized dilatation ("infundibulum") of the aorta distal to the origin of the subclavian arteries. An exposure (not shown here) made between exposures A and B shows good visualization of the infundibulum, without contrast material having reached the pulmonary artery, whereas B shows good visualization of the pulmonary artery. This indicates that the left-to-right shunt is at the level of the "infundibulum." B view also shows contrast material in the left ventricle as a result of regurgitation through the incompetent aortic valve. See also Fig. 10, C and D.



C. Exposure made 0.65 second after B shows definite visualization of the pulmonary artery, pulmonary valves (just above proximal right coronary artery), and left ventricle. Coronary arteries are well visualized.

D. The right ventricular cavity is now visualized, undoubtedly due to regurgitation of contrast material through the incompetent pulmonary valve. Contrast material in both ventricles now clearly outlines the interventricular septum, which is bowed toward the left ventricular cavity, indicating abnormally high pressure in the right ventricle.

In the line drawings, A′, B′, C′, and D′, the shaded areas indicate abnormal retrograde flow into pulmonary artery (PA) from a patent ductus at level of infundibulum (I), and later into the right ventricle (RV), presumably through an incompetent pulmonary valve (PV). Contrast material in left ventricle (LV) is due to incompetent aortic valve. Interventricular septum (IVS) can be seen because of contrast material in both ventricular cavities. Right coronary artery (RCA) passes anteriorly and downward from proximal aorta. Incidentally note that the "innominate" artery gives rise to both common carotid arteries, whereas the left subclavian arises in normal position and the right subclavian arises from an ectopic position at the level of, and slightly distal to, the left subclavian.

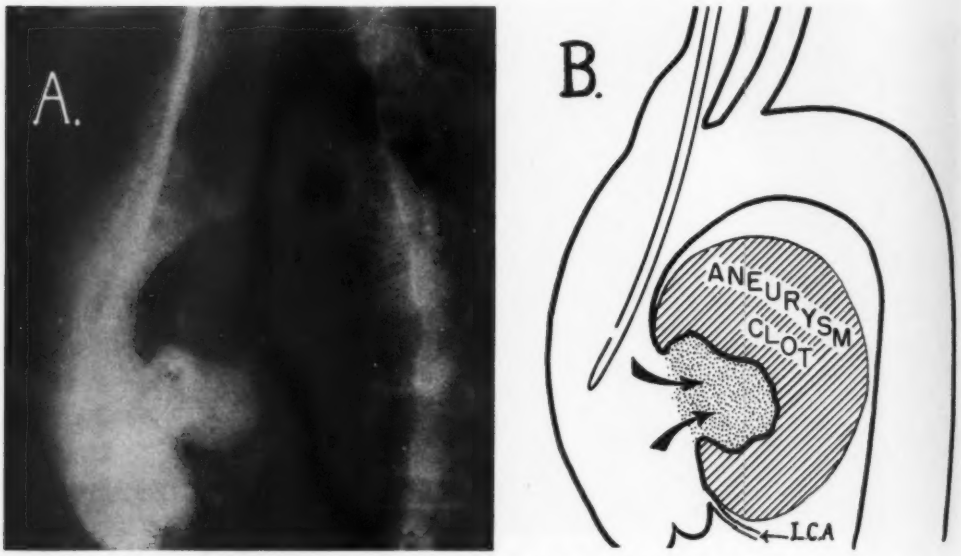


Fig. 11. - A. Unusual aneurysm originating from posterior wall of aorta, with neck of aneurysm arising 2 cm distal to the aortic valve cusps. Neck of aneurysm clearly shown, together with pool of contrast material which flows into that portion of the aneurysm not occupied by blood clot.

B. Line drawing of A. Arrows extend from aorta through the neck of the aneurysm. Stippled area represents the part of the aneurysm filled with contrast material. The line-shaded area represents portion of aneurysm filled with blood clot. Note relation of aneurysm to origin of left coronary artery (LCA).

As anticipated, aneurysms of the ascending aorta are clearly depicted by this method (Figs. 8 and 11). In those patients in whom the diagnosis of aneurysm is in doubt (Figs. 8 and 11), it is helpful to the surgeon to have a definite preoperative picture of the exact anatomy of the aneurysm, if one exists. Even if the diagnosis of aneurysm is clinically obvious, he still finds it useful to know the relation of the aneurysm to the great vessels leaving the aortic arch (Fig. 8), or the relationship to the aortic valves and coronary arteries (Figs. 9 and 11). If the aortogram shows that a mediastinal mass is not related to the aorta, this information has value in helping to plan the surgical procedure (Fig. 12).

We have been able to demonstrate the coronary artery circulation with a fair degree of regularity (Figs. 2, 3, 5, 6, 10). Our catheters and methods are being considerably modified in an attempt to do definitive angiographic studies of the coronary circulation with smaller amounts of contrast material. These results will be reported in a future publication.

COMPLICATIONS

We have obtained 51 transcarotid angiograms in 49 patients, with only 2 complications. One patient, seventy-two years old, experienced a transient left hemiparesis, which disappeared in twelve hours. In the other, a seventy-four-year-old male, a permanent left hemiparesis developed. These 2 patients were among our earliest cases at a time before we routinely tested for effects of cerebral anoxia by occluding the right common carotid for twelve minutes on the day prior to the aortogram. Their age should have caused us to question the advisability of the procedure.

There is no reason to expect that our complication rate will be any lower than that with other methods of thoracic aortography. That it is no greater is significant even though our series is still quite small. The use of 90 per cent Hypaque[6] has been attended by remarkably few side-effects and may help to diminish the incidence of

[6] Hypaque made available by Winthrop Laboratories New York 18, N. Y.

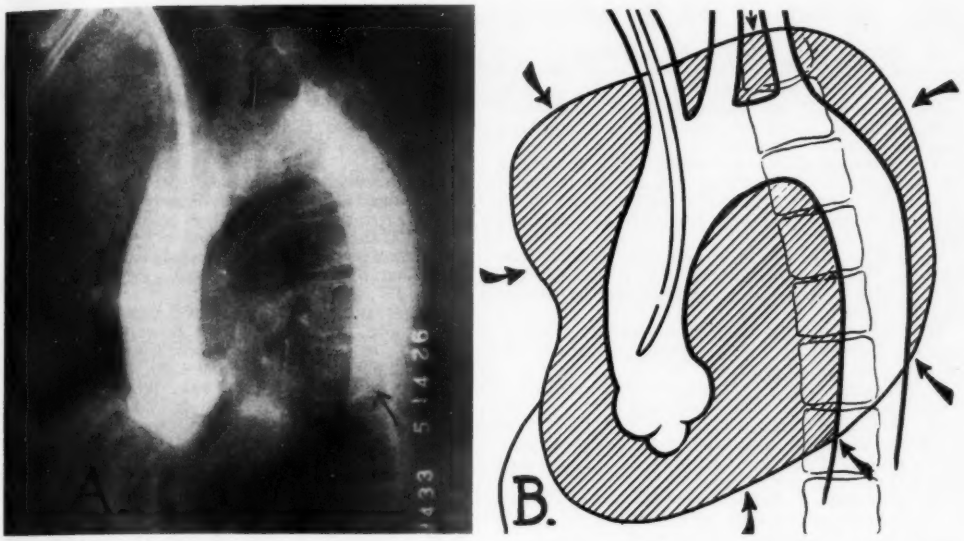


Fig. 12. A. Aortogram showing entirely normal aorta and major branches, clearly not communicating with the large mediastinal mass.
B. Line drawing of A with arrows pointing to large mediastinal mass which was removed and proved to be a benign carotid body tumor.

complications as reported in other series with other contrast materials. We feel that we effectively prevent too much of the medium entering the cerebral circulation. We certainly agree with Abrams (22) that the risks of the procedure must be weighed against the value of the information to be gained. We believe that the information gained in our small series of cases far outweighs the relatively minimal morbidity rate and precludes the surgical penalties which occasionally result from a lack of knowledge of the anatomy and physiology in operable cardiovascular lesions which are related to the aortic valve, coronary arteries, and ascending aorta.

SUMMARY

We have presented our experience with contrast visualization of the aortic valves, ascending aorta, and aortic arch by means of a large-bore, woven silk catheter, with a side opening, introduced *via* the surgically exposed right common carotid artery into the ascending aorta. A method of studying aortic valvular anatomy and valvular competence was first worked out in dogs and later found to be useful in patients being evaluated for mitral valvulotomy. Aortic insufficiency, pulmonic valvular insufficiency, aortic scarring due to syphilis, aortic valve vegetations, and pulmonary artery-aortic fistula have been clearly demonstrated in man. Aneurysms of the ascending aorta have been identified and their exact points of origin and relation to the coronary arteries and great vessels determined. The nature of complicated cardiovascular diseases can often be clarified and nonvascular lesions differentiated from vascular lesions. The coronary artery circulation can frequently be well visualized. It seems likely that other lesions, such as pulmonary artery-aortic septal defects, rupture of the sinus of Valsalva, double aortic arch, etc., can be demonstrated by this method of aortography.

In 51 aortographic studies in 49 patients two complications were encountered, only one of which was permanent. There were no deaths.

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SUMMARIO IN INTERLINGUA

Valvulographia Del Valvula Aortic E Aortographia Del Aorta Ascendente

Le autores reporta lor experientias in le visualisation contrastal del valvula aortic, del aorta ascendente, e del arco aortic per medio de un catheter de seta, texite, a calibre magne e con un apertura lateral, le qual es introducite in le aorta ascendente via le chirurgicamente exponite arteria carotic dextero-commun. Un methodo pro studiar le anatomia e competentia del valvula aortic esseva previemente elaborate in canes. Plus tarde illo se monstrava utile in patientes qui esseva evalutate como candidatos pro valvulotomia mitral. Insufficientia aortic, insufficientia pulmonovalvular, cicatrisation aortic in consequentia de syphilis, vegetationes aorto-valvular, e fistula inter arteria pulmonar e aorta esseva demonstrate clarmente in patientes human. Aneurysmas del aorta ascendente esseva identificate, e le puncto exacte de lor origine e lor relation al arterias coronari e al vasos major esseva determinate. Le natura de complicate morbos cardiovascular pote esser clarificate in multe casos, e lesiones non-vasuclar pote esser differentiate ab lesiones vascular. Le circulation del arterias coronari es frequentemente ben visualisabile. Il pare probabile que iste forma de aortographia se monstrara capace a demonstrar altere lesiones, per exemplo defectos septal inter arteria pulmonar e aorta, ruptura del sinus de Valsalva, e duple arcos aortic.

In 51 studios, le incidentia de complicationes esseva duo. Solmente un esseva permanente. Occurreva nulle morte.

Carcinoma of the Cervix

Treated During the Years 1942 to 1951 at the State University of Iowa Hospitals[1]

JOHN H. RANDALL, M.D., HIGDON B. ELKINS, M.D., and W. B. GODDARD, M.D.

DURING THE PERIOD from Sept. 1, 1942, to Jan. 1, 1951, there were admitted to the University of Iowa Hospitals 710 patients who had cervical carcinoma. Of this number, 84 had received some treatment prior to admission and 626 had been given no previous therapy, the latter forming a group of cases for which the University Hospitals could assume complete therapeutic responsibility. This latter group of patients has been thoroughly studied in order to evaluate certain changes in technic of management and to determine if there has been any improvement in the kind of material admitted.

From Table I it can be seen that there has been an increase in the number of patients in the older age groups. From 1926 to 1942, 19.6 per cent of the patients were 60 or above, while during the years 1942 to 1951 there were 27.1 per cent above that age. This does not necessarily mean that carcinoma of the cervix is becoming more common among older persons but rather that more people are living to a greater age. The average age has increased from 48.5 years in the first group (1926 to 1942) to 51.6 in the present series.

Table II shows the Schmitz staging of all cases treated entirely at the University Hospitals during the period 1926–1942 and also in the period 1942–1951. These patients were accurately staged on admission, since they were unaffected by previous therapy. There has been no increase in the percentage of Stage I cases in the present series. The percentage of patients with Stage II carcinoma has increased, while that of advanced cancer (Stages III and IV) has decreased. The operability rates (Stages I and II) during the two periods were 26.6 and 33.4 per cent, respectively. In spite of the fact that many educational campaigns against cancer are being waged by professional and lay organizations, at least two-thirds of the patients with cervical carcinoma still have advanced lesions (Stages III and IV) when the diagnosis is first made.

TABLE I: AGE DISTRIBUTION IN CARCINOMA OF CERVIX

Age Groups	1926 to 1942 No. of Cases	1942 to 1951 No. of Cases
0–19	1 (0.10%)	1 (0.14%)
20–29	38 (3.86%)	24 (3.38%)
30–39	190 (19.33%)	114 (16.05%)
40–49	318 (32.35%)	186 (26.19%)
50–59	243 (24.72%)	192 (27.04%)
60–69	156 (15.87%)	133 (18.73%)
70–79	37 (3.76%)	56 (7.88%)
80–89	0	4 (0.56%)
TOTAL	983 (100.00%)	710 (100.00%)
Youngest patient	17	19
Oldest patient	79	85
Average age	48.5	51.6

TABLE II: STAGES OF CARCINOMA OF CERVIX

Stage (Schmitz)	1926 to 1942 No. of Cases	1942 to 1951 No. of Cases
I	60 (7.8%)	45 (7.2%)
II	145 (18.8%)	164 (26.2%)
III	411 (53.4%)	312 (49.8%)
IV	153 (19.8%)	105 (16.7%)
TOTAL	769 (100.0%)	626 (100.0%)

The principal treatment of carcinoma of the cervix in our clinic continues to be irradiation therapy. Some patients with residual disease following irradiation were subjected to the Wertheim operation or to pelvic exenteration, and in a few instances interstitial radioactive gold was used. The local lesion on the cervix was treated either with radium or transvaginal x-ray therapy. Parametrial and lymphatic spread received deep x-ray therapy, usually through six skin portals: one anterior and one posterior, 15 × 15 cm. (used only since 1949); two lateral, 10 × 15 cm.; two gluteal, 10 × 10 cm. The

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following factors were used: 200 kv, target-skin distance 50 cm., Thoraeus filter, h.v.l. 2 mm. copper. A 3-mm. lead strip, 2.5 cm. wide and 0.3 cm. thick, was usually placed in the midline of the anterior and posterior portals to protect the bladder and rectum from approximately 50 per cent of the radiation through these portals. An attempt was made to give the patient a parametrial dose of 4,000 r with external irradiation.

During the forepart of the period covered by this study, alternate patients were treated with transvaginal x-ray therapy or a radium plaque. The factors used for the transvaginal roentgen irradiation were 150 kv, 1 mm. aluminum filter, distance 41.5 cm., with cylindrical specula ranging in diameter from 2.0 to 4.8 cm. Transvaginal treatments of 1,000 r were given twice weekly for a total of 5,000 r, starting one week after the beginning of external roentgen therapy. The radium application consisted of two 25-mg. sources in tandem inserted in the uterine cavity and five to seven 10-mg. tubes placed in a brass or aluminum block against the cervix. All sources were filtered with 1.5 mm. of platinum. The radium was applied for sixty hours during the latter half of the course of roentgen therapy.

In the latter part of the period, transvaginal therapy was discontinued. In many of the patients the local lesion could not be satisfactorily treated by this means because of constriction of the upper vagina. It was also felt that the method contributed little radiation to the lateral pelvic walls, where most of the lymph nodes are located. At the present time transvaginal roentgen therapy is used only to shrink the local lesion when the cervix is replaced by a large, ulcerating, bleeding cauliflower mass. Two or three treatments of 1,000 r each will reduce the size of the local lesion, will prevent much of the bleeding, and will make the radium application easier and more effective.

After transvaginal roentgen therapy was discontinued, radium therapy, with the Ernst applicator, was used to control the local lesion. If possible, 30 mg. of radium were used in the stem and 30 mg. for each lateral wing. The radium was applied toward the middle of the course of external irradiation and was left in place for a total of sixty to seventy-two hours. The Ernst applicator has not proved satisfactory for the constricted vagina or in those cases where the cervical lesion has retracted within the vaginal fornices, bringing the portio of the cervix flush with the vaginal vault.

Considerable emphasis has been placed on the general condition of the patient. Anemias are rigidly combated with blood transfusions, and pelvic infections are intensively treated with antibiotics. Patients are urged to consume an adequate diet and, if severe vomiting occurs, ample fluids and food are given parenterally. Indigent patients are hospitalized, but private patients are usually treated as outpatients if their general condition permits.

TABLE III. RESULTS OF THERAPY OF CARCINOMA OF CERVIX

Stage (League)	No. of Cases	Five-Year Survival
I	210	144 (68.5%)
II	292	121 (41.4%)
III	77	15 (19.5%)
IV	47	5 (10.6%)
TOTAL	626	285 (45.5%)

Stage (Schmitz)	No. of Cases	Five-Year Survival
I	45	33 (73.3%)
II	164	111 (67.7%)
III	312	126 (40.4%)
IV	105	15 (14.3%)
TOTAL	626	285 (45.5%)

Absolute five-year salvage: 45.5%.
Relative five-year salvage: 46.8%.

Table III shows the overall five-year end-results for all cases in this series treated entirely at the University Hospitals. Both the League of Nations and the Schmitz classifications have been used in staging the cases. The latter classification was originally used in the clinic and is still being employed so that comparisons can be made with previously published results (1). All deaths have been considered to be due to

TABLE IV: METHODS OF THERAPY IN RELATION TO FIVE-YEAR SURVIVALS

Type of Treatment	Stage I (League)		Stage II (League)		Stage III (League)		Stage IV (League)		Total	
	No. of Cases	Five-year Survivals	No. of Cases	Five-year Survivals	No. of Cases	Five-year Survivals	No. of Cases	Five-year Survivals	No. of Cases	Five-year Survivals
External x-ray irradiation and radium plaque	91	62(68.1%)	137	59(43.1%)	32	9(28.1%)	9	2(22.2%)	269	132(49.1%)
External x-ray irradiation and transvaginal irradiation	42	27(64.3%)	85	36(42.3%)	7	3(42.8%)	11	2(18.1%)	145	68(46.9%)
External x-ray irradiation and Ernst applicator	33	25(75.7%)	48	17(35.4%)	16	2(12.5%)	2	1(50.0%)	99	45(45.4%)
Radium only	25	15(60.0%)	3	2(66.7%)	0	0	1	0	29	17(58.6%)
Other methods	17	15(88.2%)	15	7(46.6%)	17	1(5.9%)	17	0	66	23(34.8%)
No therapy	2	0	4	0	5	0	7	0	18	0
TOTAL	210	144(68.6%)	292	121(41.4%)	77	15(19.5%)	47	5(10.6%)	626	285(45.5%)

cancer and no corrections have been made for natural attrition. Out of 626 patients admitted to the hospital, there have been 285 five-year survivals (45.5 per cent).

During the period 1942 to 1951, three principal technics have been used for treating the local lesion in patients with carcinoma of the cervix. The number of patients in these three groups is sufficiently large so that fairly reliable comparisons can be made. The method of external irradiation was essentially the same in all groups, with an attempted parametrial dosage of 4,000 r. Treatment of the local lesion varied: in one group the cervix was treated with transvaginal roentgen therapy, in a second by a radium plaque in conjunction with a uterine tandem, and in the third by an Ernst applicator. At first, three 10-mg. units were used in tandem in the stem of the Ernst applicator. As experience was gained, it became evident that with this distribution the rectum received too high a dose, and for this reason two units of 10 mg. each were used in the distal segment and one 10-mg. unit for the middle portion, with no radium for the proximal part of the stem. Three 10-mg. units have been used for each lateral wing when the vaginal canal was roomy and the portio of the cervix not too retracted. The Ernst applicator was carefully packed into place; otherwise rotation occurred, causing excessive irradiation of the anterior and posterior vaginal walls.

From a study of Table IV it is apparent that the end-results are about the same regardless of the method used for treatment of the local lesion. The number of survivals was slightly higher among those patients treated by a cervical plaque or by transvaginal x-ray irradiation, but the difference is too small to be statistically significant.

Twenty-nine patients were treated with radium alone, with a survival rate of 58.6 per cent. In this group, external irradiation generally was omitted because the lesions were early and seemed confined entirely to the cervix. In a few patients, however, external irradiation was considered to be contraindicated by the age or

poor general condition of the patient. Eighteen patients were given no therapy, either because they refused treatment or because their disease was so far advanced that it seemed hopeless. Since there were 18 patients who received no therapy, the relative five-year survival rate for the group of 626 patients is 46.7 per cent.

Comparison of the results in this series with those in two previous surveys (Table V) shows a progressive improvement in end-results. It is felt that the decrease in the number of advanced cases (Stages III and IV) has been partly responsible for the increased salvage, but more important has been the improvement in the technic of irradiation which has come about through increased experience. It can be said that approximately one-half of the patients being treated entirely at the University Hospitals for carcinoma of the cervix survive five years.

TABLE V: IMPROVEMENT IN END-RESULTS OF THERAPY DURING THREE SURVEYS OF CARCINOMA OF CERVIX TREATED ENTIRELY AT STATE UNIVERSITY OF IOWA HOSPITALS

Period	Stage I (Schmitz)		Stage II (Schmitz)		Stage III (Schmitz)		Stage IV (Schmitz)		Total	
	Cases	Five-year Survivals	Cases	Five-year Survivals	Cases	Five-year Survivals	Cases	Five-year Survivals	Cases	Five-year Survivals
1926–1937	30	26(86.0%)	77	46(59.0%)	234	56(23.9%)	91	0	432	128(29.6%)
1937–1942	30	27(90.0%)	68	39(57.0%)	177	63(35.5%)	62	4(6.4%)	337	133(39.4%)
1942–1951	45	33(73.3%)	164	111(67.7%)	312	126(40.4%)	105	15(14.3%)	626	285(45.5%)

There were 84 patients who had received some type of therapy in other institutions before being admitted to University Hospitals. Thirty of these were given no additional therapy, either because their previous treatment was adequate, because the neoplastic involvement was too extensive, or the general condition of the patient did not justify further measures. Forty-one patients were given additional irradiation, most often in the form of roentgen therapy alone. It is not our policy to re-irradiate patients with recurrent or residual carcinoma in an area which has previously received a tolerance dose of radiation. Thirteen of the 84 patients were subjected to radical surgery, either a Wertheim operation or a pelvic exenteration. Of the entire group of 84 patients treated elsewhere and referred to the University Hospitals, only 8 survived five years (9.5 per cent).

During the period of this study there were 35 patients who had Stage 0 carcinoma (carcinoma *in situ*). They ranged in age from twenty-six to sixty years, the average being forty-one, which is ten years younger than the average age of the group having invasive carcinoma. Table VI shows that the most common method of treating Stage 0 carcinoma has been simple total hysterectomy. In 3 cases in which the diagnosis of invasion was equivocal, a Wertheim hysterectomy was done. Five cases were treated with radium, either because of the age of the patient or because of some condition which contraindicated surgery. Thirty-four patients survived five years without recurrence; 1 died within the five-year period from severe cardiac disease.

TABLE VI: STAGE 0 CARCINOMA OF THE CERVIX 1942 to 1951

(Age range: 26 to 60 years. Average age: 41 years)

Type of Therapy	No. of Cases	Five-Year Survivals
Total hysterectomy	25	25 (100%)
Wertheim hysterectomy	3	3 (100%)
Radium application	5	4* (80%)
Other methods	2	2 (100%)
TOTAL	35	34 (97.1%)

* One patient died of cardiac failure.

The stage of disease seems to be the most important factor influencing the end-result. This has been the experience of others (2) and is definitely borne out by a study of Tables III, IV, and V. As long as the neoplasm is confined to the cervix, the end-result from adequate therapy, be it surgery or irradiation, will be excellent. Some of the patients have been previously subjected to simple total hysterectomy and

are later sent to the University Hospitals when residual or recurrent carcinoma becomes evident. These cases are difficult to treat because removal of the uterus limits the amount of radium which can be safely applied, and incomplete surgery seems to make residual carcinoma more resistant to irradiation.

Patients between the ages of thirty and sixty seem to have better end-results than the younger and older age groups (Table VII). Women under the age of thirty have

TABLE VII: AGE IN RELATION TO SURVIVALS

Age	No. of Cases	Five-Year Survivals
Under 20	1	1 (100%)
20–29	21	8 (38.1%)
30–39	95	47 (49.5%)
40–49	162	89 (54.9%)
50–59	167	76 (45.5%)
60–69	122	51 (41.8%)
70–79	54	13 (24.1%)
Over 80	4	0
TOTAL	626	285 (45.5%)

carcinomas which are radiosensitive but tend to metastasize earlier to regional nodes and distant organs. Older patients often have a contracted vagina which makes radium application difficult and less effective. Those near or beyond the age of seventy appear to tolerate roentgen therapy more poorly than the younger and more vigorous patients, thus limiting the amount of radiation that can be given to the lateral pelvic regions.

In all cases a biopsy is taken for histologic study on first admission to the hospital. All epidermoid carcinomas are graded according to cell maturity. Most of the cervical cancers tend to be immature and fall into the transitional and spindle-cell groups. From a study of Table VIII, it appears that the end-result has little relationship to the histology of the tumor. The biological characteristics of cancer and not the histologic picture of its cells determine the outcome of treatment. Adenocarcinomas (5.6 per cent) are often said to respond poorly to irradiation, but in this study they responded equally as well as the epidermoid carcinomas.

TABLE VIII: RELATION OF HISTOLOGIC TYPE OF CERVICAL CARCINOMA TO END-RESULTS

Type of Carcinoma	No. of Cases	Five-Year Survivals
Adenocarcinoma	35	16 (45.7%)
Spinal-cell (most mature)	79	37 (46.8%)
Transitional (middle mature)	260	119 (45.7%)
Spindle (least mature)	221	94 (42.5%)
Unclassified	31	19 (61.3%)
TOTAL	626	285 (45.5%)

Irradiation therapy, when given to the point of full tolerance, carries certain inherent risks and dangers. During and following therapy, proctitis with severe diarrhea is a common complication but can usually be controlled by administration of powdered opium and lead acetate, 1 grain each. The urinary bladder tolerates treatment better than the lower intestinal tract but, when interstitial cystitis occurs, it becomes a very troublesome complication. Loss of weight may be excessive and often justifies a limitation of therapy, especially in older patients. A definite primary mortality may be associated with roentgen or radium therapy. In the present series, 8 deaths (1.1 per cent) could be attributed directly to the effects of irradiation.

Later complications, such as fistulas—vesicovaginal, rectal, or a combination of the two—occurred in 7 per cent of the patients. It is often difficult to tell whether a fistula is due to progression of the disease or to irradiation necrosis. A late complication following roentgen therapy is fracture of the neck of the femur as a result of atrophic disturbances. This occurred in 20 cases, 2.8 per cent of the series. A pain in the region of the neck of the femur should make one think of this complication and justifies roentgenographic investigation. Early recognition of this complication and proper orthopedic management offer a good prognosis.

It is often difficult to tell if a patient is making satisfactory progress following irradiation therapy. This is especially true of those patients who have had a complete regression of the local tumor but experience such symptoms as pain in the back, lower abdomen, or pelvis, loss of

weight, and swelling of one or both legs. Patients who return for a check-up examination with one or more of these symptoms usually have recurrent carcinoma, even though there is no sign of residual disease in the region of the cervix and no palpatory evidence of spread to the parametria or regional nodes.

SUMMARY AND CONCLUSIONS

1. From Sept. 1, 1942, to Jan. 1, 1951, there were admitted to the State University of Iowa Hospitals, 710 patients having carcinoma of the cervix. Six hundred and twenty-six of these patients had received no therapy for their cancer prior to admission.

2. Patients were treated chiefly with irradiation, roentgen therapy being given through six skin portals so that the average parametrial dose was 4,000 r.

3. The local lesion was most commonly treated by one of three methods: a radium plaque with a uterine tandem, transvaginal roentgen therapy, or an Ernst applicator.

4. The absolute overall five-year survival rate for 626 patients treated entirely at the University Hospitals was 45.5 per cent. Eighteen patients were not treated, making the survival rate for treated patients 46.7 per cent.

5. The five-year salvage rate was about the same regardless of the method of treatment of the local lesion.

6. The greatest single factor in end-results was the stage of the disease.

7. The younger and older patients responded more poorly than those in the middle age groups.

8. The histologic picture of the carcinoma has little or no influence upon the end-result.

9. There has been a definite improvement in the percentage of five-year survivals in the present series as compared to previous surveys. This has been due chiefly to the improvement in the technic of therapy, and to a lesser extent to the decrease in the number of advanced cases and a slight increase in the number of patients with early lesions.

10. Thirty-five patients with carcinoma *in situ* were effectively treated either with simple total hysterectomy or radium application.

11. Although there is a definite mortality risk (1 per cent) and certain annoying complications from irradiation, this type of therapy continues to be the best treatment of carcinoma of the cervix for most clinics.

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SUMMARIO IN INTERLINGUA

Carcinoma Del Cervice, Tractate Inter 1942 E 1951 Al Hospitales Del Universitate Statal Iowa

Inter le 1 de septembre 1942 e le 1 de januario 1951, 710 patientes con carcinoma del cervice esseva admittite al Hospitales Del Universitate Statal Iowa. Le serie includeva 626 patientes qui habeva recipite nulle therapia pro lor cancere ante le tempore de lor hospitalisation. Le patientes esseva tractate principalmente con irradiation. Le roentgenotherapia esseva administrate per sex portales cutanee de maniera que le dose parametrial medie amontava a 4.000 r.

Le lesion local esseva tractate le plus communmente per un de tres methodos: Un placa a radium con un tandem uterin, roentgenotherapia transvaginal, o un applicator de Ernst.

Le absolute superviventia quinquenne general pro le 626 patientes qui esseva tractate exclusivemente al Hospitales del Universitate esseva 45,5 pro cento. Deceocto patientes remaneva sin tractamento, de maniera que le superviventia pro patientes tractate monta a 46,7 pro cento. Le

nivello del salvation quinquenne esseva plus o minus le mesme sin reguardo al methodo de tractar le lesion local.

Le plus importante factor individual in le determination del resultatos final esseva le stadio del morbo. Le plus juvene e le plus vetule patientes respondeva minus ben que le patientes de etates intermediari. Le aspecto histologic del carcinoma ha pauc o nulle signification pro le resultato final.

Es a notar un definite melioration del procentage de superviventia quinquenne in le presente serie in comparation con previe studios. Iste facto resulta principalmente del melioration in le technicas therapeutic e minus extensemente del reduction in le numero de casos avantiate e de un leve augmento del numero de patientes con-lesiones in stadios precoce.

Trenta-cinque patientes con carcinoma in sito esseva tractate efficacemente con simple hysterectomia total o con application de radium.

Ben que il existe un definite risco de mortalitate (1 pro cento) e ben que il occurre certe enoiose complicationes in le uso de irradiation, iste typo de therapia continua esser le melior tractamento pro carcinoma del cervice in le majoritate del clinicas.

Obstructive Lesions of the Duodenum Distal to the Bulb[1]

CHARLES H. BROWN, M.D., and WILLIAM C. STRITTMATTER, M.D.

OBSTRUCTION IN THE duodenum distal to the bulb was described by Boerneurus in 1752, by De Haen in 1763, by Rokitansky in 1849, and by many others subsequently. It is the purpose of this paper to review the various lesions that may cause postbulbar duodenal obstruction, to discuss their roentgen appearance, and to describe some unusual and uncommon lesions.

The second or descending portion of the duodenum is retroperitoneal and extends along the right side of the vertebral column from L-2 to L-3 or L-4. The head of the pancreas lies within the duodenal loop. The common duct passes behind the duodenal bulb and, with the pancreatic duct, enters the duodenum obliquely along the medial side of the second portion. The third portion of the duodenum passes horizontally and is crossed by the superior mesenteric vessels and root of the mesentery. Coursing upward again, the fourth portion of the duodenum is fixed by the ligament of Treitz at the duodenojejunal junction (1).

Because of its proximity to many other vital structures, the duodenum is subject to multiple lesions, both intrinsic and extrinsic. The common bile duct and the pancreatic duct empty into it, and it is in close anatomic relationship to the head of the pancreas.

Obstruction of the second portion of the duodenum resembles pyloric obstruction except that with the former there is a large dilated bulb proximal to the site of the block. Most lesions of occurring in this area cause only partial or intermittent obstruction. The fourth part of the duodenum at the ligament of Treitz is the most fixed portion of the gastrointestinal tract; pressure from any cause at this location may result in obstruction.

Causes of postbulbar duodenal obstruction that we have observed may be classified as follows:

I. Developmental or congenital factors
   - A. Occlusion by superior mesenteric artery or "duodenal ileus"
   - B. Obstruction at ligament of Treitz
   - C. Volvulus of jejunum
   - D. Congenital band
   - E. Malrotation of small intestine
   - F. Annular pancreas

II. Extrinsic factors (extraduodenal disease)
   - A. Abdominal aneurysm
   - B. Pancreatic lesions
     1. Benign cyst
     2. Islet-cell adenoma
     3. Carcinoma
   - C. Enlarged mesenteric nodes
   - D. Retroperitoneal tumors

III. Intrinsic factors (intraduodenal disease)
   - A. Ulceration
     1. Ulcer, second portion of duodenum
     2. Marginal ulcer
     3. Duodenitis (regional enteritis)
   - B. Neoplasm
     1. Benign
     2. Malignant
        - (*a*) Carcinoma
        - (*b*) Sarcoma (lymphosarcoma, Hodgkin's sarcoma, reticular-cell sarcoma)

IV. Unknown, *e.g.*, lupus erythematosus

DEVELOPMENTAL OR CONGENITAL FACTORS

Duodenal ileus may be caused by the mesentery or the superior mesenteric artery compressing the duodenum against the spine at the site where the mesentery crosses the third portion (Fig. 1). This compression results in dilatation of the duodenum proximally and slow gastric emptying. It is frequently seen in patients with ptosis or malrotation of the small bowel or colon. Many authorities believe that the condition predisposes to duodenal or gastric ulcer because of resulting stasis of acid gastric juice. Symptoms

[1] From the Departments of Gastroenterology (C. H. B.) and of Radiology (W. C. S.), The Cleveland Clinic Foundation, and The Frank E. Bunts Educational Institute, Cleveland, Ohio. Accepted for publication in November 1957.

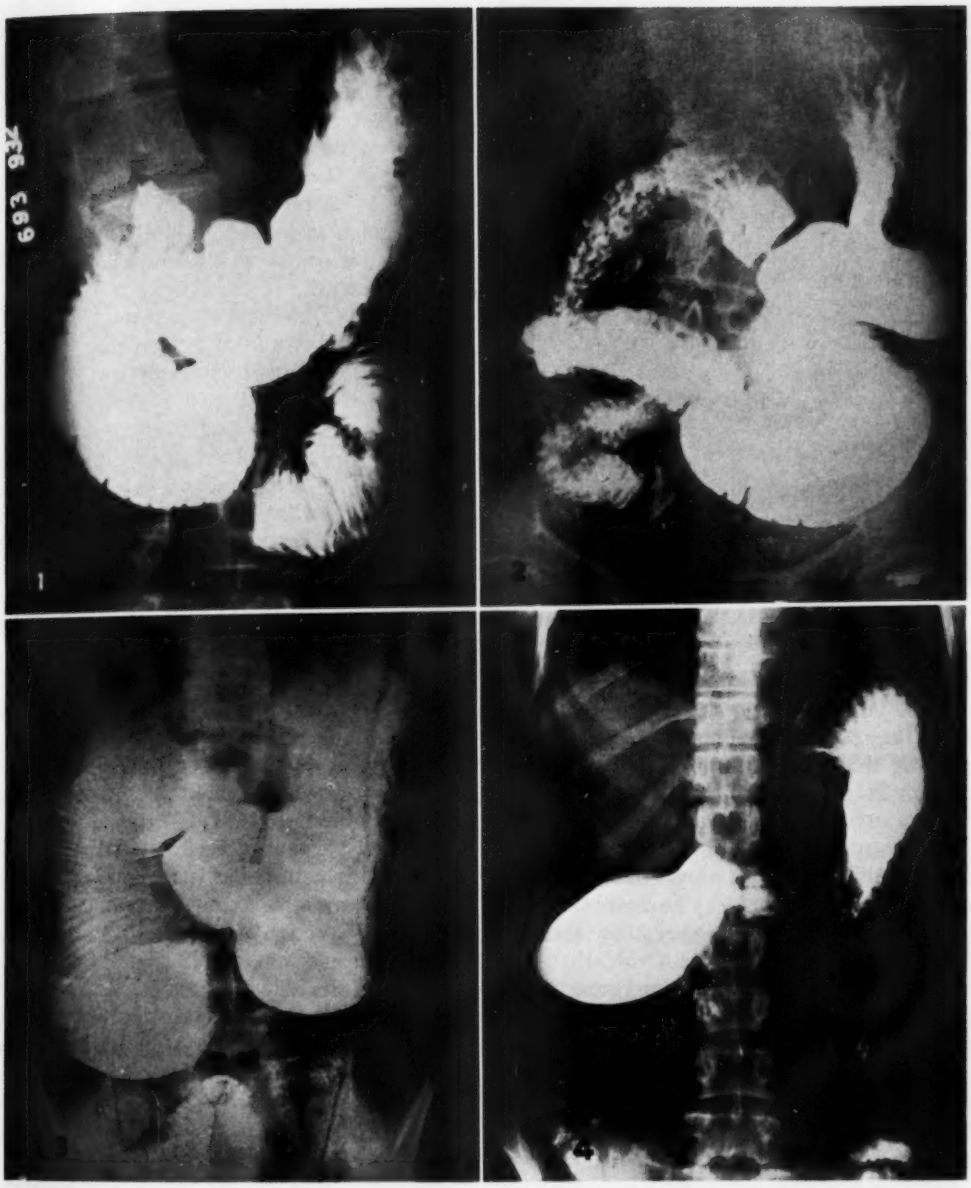

Fig. 1. Roentgenogram, after barium swallow, of patient having duodenal ileus due to occlusion by superior mesenteric artery. The stomach is filled with barium and there is dilatation of first, second, and third portions of the duodenum. The patient was treated surgically.

Fig. 2. Roentgenogram of patient having complete volvulus of small bowel with the jejunum herniated through its own mesentery. Note slight dilatation and peculiar course of duodenum. The loops of jejunum appear to be in a sac in the left abdomen.

Fig. 3. Roentgenogram, after barium swallow, of patient having dilated stomach and duodenum due to a congenital band in the region of the ligament of Treitz.

Fig. 4. Roentgenogram of patient having an annular pancreas. Note huge dilated duodenal bulb.

Fig. 5. Roentgenogram of patient having a fusiform aneurysm of the abdominal aorta. Note dilatation of first, second, and third portions of duodenum.

consist of intermittent attacks of nausea and vomiting. The diagnosis can be made only by demonstration of the dilated duodenum at fluoroscopy and of retention of barium in both the stomach and duodenum. One of our patients (Fig. 1) who had duodenal ileus as a result of occlusion by the superior mesenteric artery had severe symptoms that were not relieved by medical treatment. This was one of the few cases of this type in which operation (duodenojejunostomy) was advised and performed.

Obstruction at the ligament of Treitz or tumors in the proximal jejunum may also cause dilatation of the duodenum and simulate duodenal obstruction.

Volvulus of the jejunum may result in partial obstruction with dilatation of the duodenum. In one of our patients, a 73-year-old man, there was slight dilatation of the duodenum and it followed a peculiar course (Fig. 2). Roentgenographically, the loops of jejunum appeared to be in a sac in the left abdomen. The patient complained of diarrhea, gas, and crampy abdominal pain. Surgery revealed a complete volvulus of the small bowel, with the jejunum herniated through its own mesentery.

Complete atresia or stenosis of the duodenum is incompatible with life. Occasionally in the newborn infant this condition may be recognized on a plain film; the stomach and duodenal bulb are dilated and there is no gas in the remainder of the intestinal tract.

Obstruction may be caused by a *congenital band* across the third portion of the duodenum. Roentgenographically, this condition is identical with occlusion by the superior mesenteric artery. One of our patients, a 24-year-old woman, complained of bloating, a feeling of fullness after eating, and vomiting. These symptoms had been present for fourteen years. After a barium swallow, roentgenograms demonstrated partial duodenal obstruction (Fig. 3), which at operation was found to be due to a congenital band. The symptoms were relieved after the duodenojejunostomy.

Malrotation of the small intestine is another infrequent cause of duodenal obstruction.

In the newborn infant, *annular pancreas* may result in complete duodenal obstruction; in the adult, it usually causes minimal obstruction (2) but also is capable of producing acute or chronic obstruction. In the child with complete obstruction the diagnosis can be made on the basis of findings on a plain film of the abdomen. The "double-bubble sign," which is merely fluid levels in the dilated stomach and duodenal bulb, is pathognomonic. In the adult, the diagnosis can be established only by a series of roentgenograms of the upper gastrointestinal tract. The degree of dilatation of the duodenum and stomach depends on the severity of the obstruction. The duodenum usually is pulled toward the pancreas at the end of the annulus. The mucosa may be "ironed out" but not destroyed as it is by a carcinoma of the duodenum. The narrowing usually is ec-

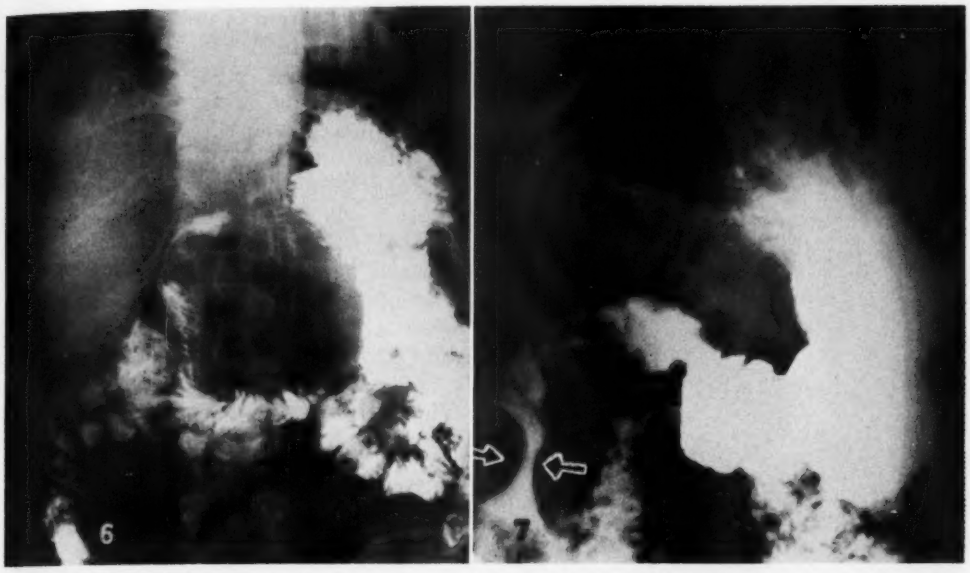

Fig. 6. Roentgenogram showing large pseudocyst arising from region of head of pancreas and almost completely filling lesser peritoneal cavity. Note elevation of gastric antrum and widening of duodenal loop.
Fig. 7. Roentgenogram showing narrowing of second part of duodenum secondary to pancreatitis and a pseudocyst of the pancreas.

centric. One of our patients, a forty-five-year-old woman, complained of aching pains in the epigastrium which lasted for two or three days at a time. There was no nausea or vomiting. Contrast studies of the stomach showed a huge, dilated duodenal bulb (Fig. 4). At operation a rim of pancreatic tissue was found completely encircling the second portion of the duodenum. A duodenostomy was performed. The patient has been asymptomatic for two years postoperatively, but roentgenograms demonstrate a dilated first portion of the duodenum without obstruction to the passage of barium.

EXTRINSIC FACTORS

(*Extraduodenal Disease*)

Enlargement or tumor of any of the multiple structures adjacent to the duodenum may cause partial or complete duodenal obstruction.

Aneurysm of the abdominal aorta is a rare cause of duodenal ileus. One of our patients, a 74-year-old man, was seen with dilatation of the first, second, and third portions of the duodenum (Fig. 5). He complained of vomiting approximately one hour after meals. This occurred, however, only when he had been lying down, and could be prevented by his remaining in a sitting position. Roentgen studies of the stomach showed a partial duodenal obstruction. At exploratory laparotomy, a fusiform aneurysm of the abdominal aorta, approximately 5 cm. in diameter, was found. The third portion of the duodenum passed over the aneurysmal mass, which was producing the partial obstruction. Following a duodenojejunostomy the patient had no further gastrointestinal symptoms; he died three years postoperatively from a bronchogenic neoplasm.

Lesions of the head of the pancreas, such as carcinoma, islet-cell adenoma, benign cyst, and an inflammatory mass secondary to pancreatitis, may cause compression and partial obstruction of the duodenum (Figs. 6, 7, and 8). Large masses in the head of the pancreas also cause elevation of the gastric antrum and even delay in emptying of the stomach. There may be widening of the duodenal loop, but this

Fig. 8. Roentgenogram showing wide duodenal loop resulting from large anaplastic carcinoma of pancreas.

must be correlated with the patient's habitus, since the high "steer horn" stomach also is associated with a wide duodenal loop. There may be actual invasion of the duodenum by pancreatic neoplasm. The "inverted 3 sign" of Frostberg may be due to carcinoma of the head of the pancreas, carcinoma of the ampulla of Vater, or pancreatitis (3).

In one of our patients, a roentgenogram showed a large pseudocyst arising from the region of the head of the pancreas and almost completely filling the lesser peritoneal cavity (Fig. 6). Barium study showed elevation of the gastric antrum and widening of the duodenal loop. At operation, approximately 800 ml. of watery fluid was removed from the pseudocyst. Another patient had narrowing of the second part of the duodenum secondary to pancreatitis and a pseudocyst of the pancreas with cystic fluid between the coats of the duodenal wall (Fig. 7). This patient also had cholelithiasis and diabetes mellitus. He has been well, except for diabetes, for three years after operation (cholecystectomy, gastric resection, probing of pancreatic duct, and resection of undermined mucosa in the duodenum).

In one of our patients, an islet-cell adenoma of the head of the pancreas exerted pressure on the second portion of the duodenum, causing dilatation of the bulb (4). This adenoma was nonfunctioning, but was unusual in that it was in the head of the pancreas and produced obstructive symptoms. Carcinoma of the head of the pancreas rarely causes duodenal obstruction. In another case, a wide duodenal loop resulted from a large anaplastic carcinoma of the pancreas (Fig. 8); the patient had some gastric retention due to compression. In a third instance, roentgen demonstration of dilatation of the first, second, and third portions of the duodenum suggested partial obstruction in the region of the ligament of Treitz. At operation a stony hard, irregular mass, 8 by 5 cm., was found in the region of the head of the pancreas, firmly fixed posteriorly and extending to the transverse mesocolon and ligament of Treitz, where it produced an almost complete obstruction. A posterior gastroenterostomy was performed. Biopsy showed the tumor to be adenocarcinoma, consistent with pancreatic origin.

Both *enlarged mesenteric nodes* and *retroperitoneal tumors* may exert pressure on the second portion of the duodenum and cause partial obstruction.

INTRINSIC FACTORS

(*Intraduodenal Disease*)

Postbulbar duodenal ulcer is not a rare entity and is a frequent cause of gastrointestinal bleeding. The diagnosis can be based on the findings on barium study, but a careful examination of the second portion of the duodenum must be made. These lesions may cause partial obstruction (5). In one of our patients there was a large ulcer crater in the second portion of the duodenum, with spasm and edema about the ulcer causing partial obstruction (Fig. 9). An infiltrating lesion was considered possible, but progress roentgen studies six and twelve weeks later showed healing of

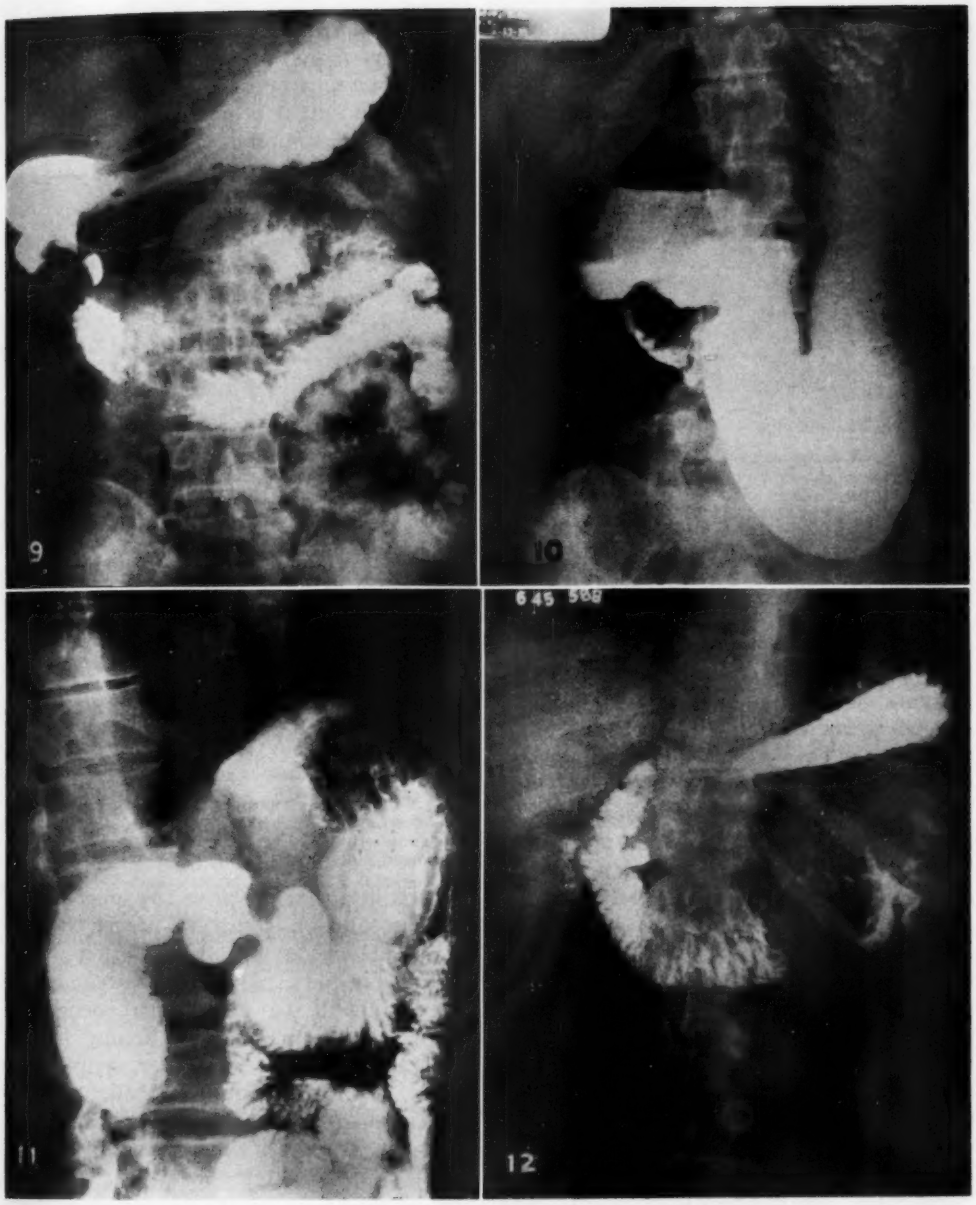

Fig. 9. Roentgenogram showing a large ulcer crater in second portion of duodenum.

Fig. 10. Roentgenogram, three hours after barium swallow, of patient having regional enteritis that caused dilatation of duodenal bulb. Note large amount of barium in stomach.

Fig. 11. Roentgenogram showing annular constricting carcinoma that caused almost complete obstruction at junction of second and third portions of duodenum. This patient had had a gastroenterostomy.

Fig. 12. Roentgenogram of patient having lymphosarcoma causing dilatation of duodenum proximal to ligament of Treitz. Note constriction of proximal jejunum, with overhanging margins and destruction of mucosal pattern.

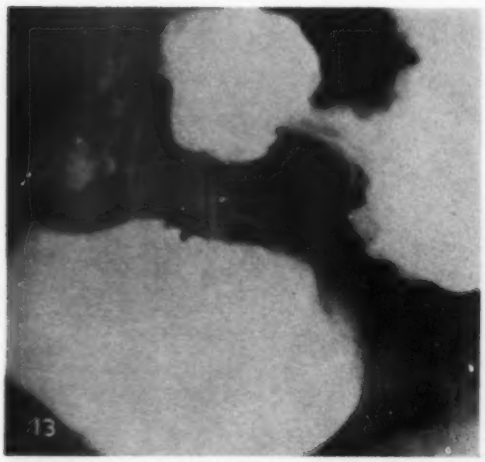

Fig. 13. Roentgenogram of patient with lupus erythematosus, showing marked dilatation of second portion of duodenum. She had no gastrointestinal complaints.

the ulcer. One year later the duodenum appeared normal on roentgenograms.

Dilatation of the duodenum may occur secondary to a *marginal ulcer* in a patient with a gastroenterostomy. In one of our patients, who had had a gastroenterostomy sixteen years earlier, the roentgenogram demonstrated poor function of the stoma with a partial obstruction of the afferent loop. A subtotal gastric resection was performed. A palpable stomal ulcer with scarring and adhesion to the colon, causing an annular constriction of the afferent loop just proximal to the stoma, was found.

Regional enteritis (6) may involve the duodenum and cause dilatation of the bulb. One of our patients had partial gastric obstruction, with a large amount of barium remaining in the stomach at the end of three hours (Fig. 10). This retention was thought to be due to a partially obstructing duodenal ulcer. Symptoms of obstruction (vomiting) had been present for the previous year. A duodenojejunostomy was performed and the duodenum was found to be thickened, edematous and, in accordance with the biopsy, apparently involved by a diffuse inflammatory process. The patient has remained asymptomatic for six years postoperatively.

Both *benign and malignant neoplasms* of the duodenum can cause obstruction (3, 7). Carcinoma of the duodenum (8) is considerably more common than sarcoma. Carcinoma may occur in any portion of the duodenum, but it is most common in the region of the ampulla. It usually is an annular lesion that destroys the mucosa and may produce a complete or partial obstruction with resultant dilatation proximally (Fig. 11). Duodenal carcinoma is often difficult to distinguish roentgenographically from a tumor arising in the pancreas, ampulla of Vater, papilla of Vater, or distal common bile duct or pancreatic ducts. Lymphosarcoma may involve any portion of the duodenum. In one of our patients a lymphosarcoma distal to the ligament of Treitz caused dilatation of the duodenum proximal to the ligament of Treitz (Fig. 12).

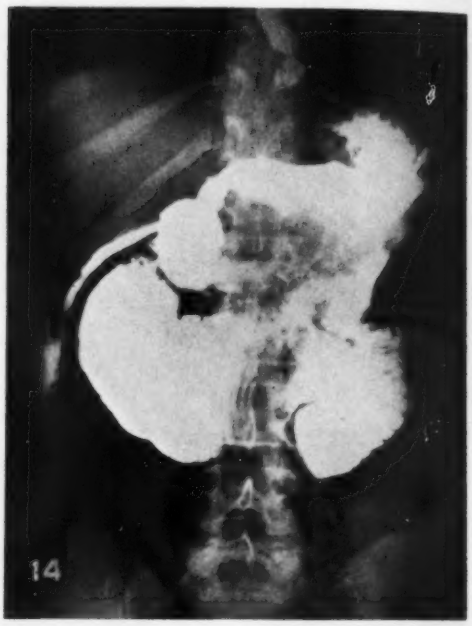

Fig. 14. Roentgenogram of patient shown in Fig. 13, one year later, after barium swallow. Note that the duodenum still is dilated and there is now a fistulous tract from a perforated peptic ulcer.

UNKNOWN FACTORS

Brown, Shirey, and Haserick (9) reported three cases of duodenal "ileus" or dilatation of the duodenum and *systemic lupus*

erythematosus. The cause of the dilatation in these patients is not clear, since no obstructing lesion has been found. Collagen deposition in the submucosa, vascular changes associated with lupus erythematosus, or a localized neurogenic phenomenon seem the most likely causes of the dilatation and "ileus." Figure 13 shows marked dilatation in the second portion of the duodenum in a patient with lupus erythematosus. At that time she had no gastrointestinal complaints. She was treated with steroid therapy but returned a year later with generalized abdominal pain, distention, and a temperature of 103° F. Roentgenograms after a barium swallow showed the dilated duodenum and a fistulous tract from a perforated peptic ulcer (Fig. 14). The patient seemed to respond satisfactorily to therapy, but six weeks after the last admission she died unexpectedly at home.

SUMMARY

The multiple lesions that may cause complete or partial obstruction of the duodenum may be grouped in three major categories: congenital, extrinsic, and intrinsic. Symptoms are those of obstruction, and thorough roentgen examination of the area is the only method of making a preoperative diagnosis. In some cases, especially those in which the lesion occurs in the region of the ampulla of Vater, it is impossible to distinguish intrinsic from extrinsic disease. A large dilated duodenal bulb may be the only roentgen sign of an obstructing lesion distally. Frequently, the exact cause of the obstruction can be determined only at operation.

Resection of the duodenum is a formidable procedure. It is rarely considered for benign lesions and may not always be possible for malignant lesions. In the treatment of benign and malignant disease for which only a palliative procedure is possible, a duodenojejunostomy is preferable to a gastroenterostomy.

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SUMMARIO IN INTERLINGUA

Lesiones Obstructive Del Duodeno Distal Al Bulbo

Le multiple lesiones que pote causar un obstruction complete o partial del duodeno pote esser gruppate in tres categorias major: Congenite, extrinsec, e intrinsec. Le symptomas es le symptomas de obstruction, e le plus meticulose examine roentgenologic del area es le sol methodo pro establir un diagnose preoperatori. In certe casos, specialmente quando le lesion occurre in le region del ampulla de Vater, il es impossibile distinguer inter morbo intrinsec e morbo extrinsec. Un grande dilatate bulbo duodenal pote esser le sol signo roentgenographic de un lesion obstructive de sito distal.

Le resection del duodeno es un manovra formidabile. Illo es rarmente considerate quando il se tracta de un lesion benigne, e a vices illo es impossibile quando il se tracta de un lesion maligne.

An Aid to the Diagnosis of Pneumoperitoneum from Supine Abdominal Films[1]

E. H. SCHULTZ, JR., M.D.[2]

A RADIOLUCENT STRIPE under the diaphragm, seen on films of the abdomen made in upright position, is the classical roentgen sign of intraperitoneal gas. This finding is present in about 80 per cent of gastrointestinal perforations. Sometimes, however, only films made in supine position are available for study. On these, the diagnosis may still be made by detection of the visible contour of the outer (serosal) surface of a segment of bowel.

The outline of the serosal surface of the bowel by contrast with intraperitoneal gas was described in 1941 by Rigler (3), but there has been little mention of the sign in the subsequent literature. Both Rigler and Frimann-Dahl (1) consider the finding pathognomonic of pneumoperitoneum. Although it cannot be detected as frequently as subdiaphragmatic gas on upright films, the visible outer bowel surface on supine films is not a rarity with pneumoperitoneum. Study of the films of patients with spontaneous pneumoperitoneum at this hospital revealed that the outline of the outer bowel wall was visible

Fig. 1. In supine position the outer wall of a loop of bowel is outlined by gas contrast, indicated by arrows. A shadow thought to represent the falciform ligament outlined by gas contrast is marked by double arrows. A perforated gastric ulcer was found at surgical exploration.

[1] From the Department of Radiology, School of Medicine of the University of North Carolina, and the Radiologic Service of the North Carolina Memorial Hospital, Chapel Hill. Accepted for publication in October 1957.

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in over one-third of the cases. An example is shown in Figure 1.

In each of the patients with this finding a moderate to large amount of free gas was present. In most instances a large quantity of free fluid (over 1,000 c.c.) was found in the abdomen at operation. The sign was most commonly associated with perforated gastric ulcer. The cases support Rigler's original impression that the visible outer bowel surface is usually evident only in the presence of relatively large amounts of peritoneal gas *and* fluid.

To test the importance of abdominal fluid in the production of the roentgen sign, pneumoperitoneum of increasing increments was induced in 2 mongrel dogs of comparable size. In the first dog, 1,500 c.c. of air were necessary to produce a visible outline of the outer bowel surface on supine films. In the second dog, 400 c.c. of saline were instilled into the abdominal cavity before air was introduced. The outer bowel surface could then be defined with the addition of only 400 c.c. of air.

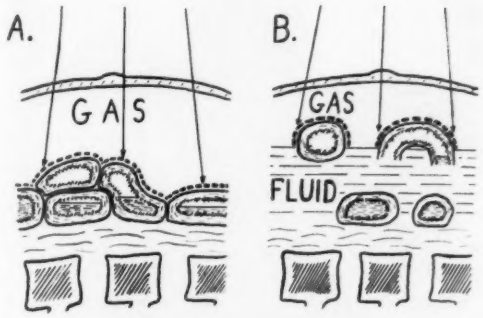

Fig. 2. With pneumoperitoneum alone (A) the bowel lies in the dependent portion of the abdominal cavity. The interface between bowel wall and intraperitoneal gas (indicated by broken line) is perpendicular or oblique to the roentgen rays, shown by arrows. With peritoneal gas and fluid (B), any gas-distended bowel loops rise to the surface of the fluid. The interface between these loops and the free gas (broken line) may be parallel to the roentgen rays; the outer bowel surface then can be depicted on the film by contrast with the adjacent gas.

Fig. 3. Cross-table lateral view of the abdomen to illustrate floating bowel loops. This patient had free fluid and a therapeutic pneumoperitoneum. The outer bowel margin was visible on the anteroposterior film of the abdomen (not illustrated).

On films of both patients and dogs it was noted that it was the outer walls of gas-filled loops of bowel which were almost always demonstrated. This fact and consideration of the physical factors suggest why the presence of peritoneal fluid brings out the sign on supine films. With peritoneal gas alone, the bowel loops fall dorsad by the force of gravity, gathering together, with the result that the outer surface of one segment is adjacent to that of another. The interface between the free gas and the more ventral loops is perpendicular or oblique to the roentgen rays, so that no clear shadow is produced on the film (Fig. 2, A). If both fluid and gas are present, however, any gas-filled segments of bowel float to the surface of the fluid, which tends to

Fig. 4. A case of perforation of the sigmoid colon with free intraperitoneal gas. In upright position (A) no gas was identified below the diaphragm. On the film made in supine position (B) the outer surface of several bowel segments was clearly visible, indicated by arrows. See text.

separate individual loops. Part of the interface between the free gas and the bowel wall is then parallel to the roentgen rays, and the contrast is evident on the film (Fig. 2, B). The tendency for gas-filled loops to assume this arrangement is further illustrated in Figure 3, a lateral supine view of a patient with abdominal fluid and a therapeutic pneumoperitoneum.

An interesting finding noted on the supine film of one patient and on the films of both dogs was a shadow consistent with the position and appearance of the falciform ligament (Fig. 1). Demonstration of the falciform ligament by gas contrast after spontaneous pneumoperitoneum has not to our knowledge been previously described. Its identification on supine films would seem to be equal in significance to the other roentgen signs of free peritoneal gas.

Recognition of the visible outer bowel wall will be of value primarily, of course, where supine films only are available; upright films remain the best means for the radiologic diagnosis of pneumoperitoneum. Rarely, however, the subdiaphragmatic peritoneal space can be obliterated by disease and gas will not collect there even in upright position (2). In this situation the detection of pneumoperitoneum on supine or other films is of paramount importance. The following brief case report illustrates this point.

CASE REPORT

A 54-year-old male was admitted to the North Carolina Memorial Hospital for evaluation and therapy of chronic rheumatoid arthritis. The past history otherwise was not remarkable. Physical examination revealed the arthritic deformities but no other significant abnormalities.

The stool specimen reacted positively with benzidine, and sigmoidoscopy was done in a search for an origin of the occult blood. No abnormality was seen up to 20 cm. A few hours after the examination the patient complained of abdominal pain, and this increased in severity on the following day. Rebound tenderness and abdominal muscle spasm became evident.

Roentgen examination of the abdomen was then done. With the patient upright there was no evidence of gas under the diaphragm (Fig. 4, A). On the film made in supine position, however, a definite shadow was visible, consistent with the outer surface of the bowel wall (Fig. 4, B). Repeat films were made and again the serosal margin of the bowel wall was outlined by gas contrast, although no gas appeared below the diaphragm. Lateral decubitus and cross-table lateral views confirmed the presence of a large pneumoperitoneum.

At surgical exploration a large quantity of gas escaped through the incision, and a great deal of fluid and feces was found in the abdomen. A perforation of the sigmoid colon was identified and closed. The patient recovered.

No definite explanation can be made for the failure of the peritoneal gas to move to the subdiaphragmatic space in upright position. Chest films revealed evidence of pulmonary tuberculosis, and it is possible that the space had been sealed by an old inflammatory process.

COMMENT

A suspected shadow of gas outlining the outer bowel surface must be differentiated from gas within the lumen of adjacent bowel loops. Similarly, the radiolucent flank stripe beside the ascending and descending colon should not be confused with the radiologic sign of free peritoneal gas. These normal shadows practically never cause confusion if the films are carefully analyzed.

If doubt exists as to the presence or absence of a visible outer bowel surface, cross-table lateral view of the abdomen can confirm the presence of free gas without the necessity of moving the patient from the supine position.

SUMMARY

Radiologic examination of the abdomen in the erect position is the best means of detecting pneumoperitoneum. When only supine films are available, the diagnosis still can be made if the outer bowel wall is visible as a result of gas contrast. A quantity of abdominal fluid is usually present when the sign is seen.

The value of the finding is illustrated by a case in which free peritoneal gas failed to ascend to the subdiaphragmatic space in upright position.

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SUMMARIO IN INTERLINGUA

Un Adjuta In Le Diagnose De Pneumoperitoneo Per Roentgenogrammas Decubito-Abdominal

Ben que le examine radiologic del abdomine con le patiente in postura erecte es le melior methodo pro deteger pneumoperitoneo, il existe casos in que solmente radiogrammas a position decubital es disponibile. In iste ultime gruppo de casos e in altere casos in que le spatio subdiaphragmatic es oblitterate per un processo pathologic, il es a vices possibile effectuar un diagnose super le base del delineation in le radiogramma del pariete exterior (serosal) del intestino como resultato de contrasto de gas.

Iste signo es manifeste le plus frequentemente quando amontas considerabile de fluido peritonee es presente. Sub tal conditiones le ansas intestinal con lor contento de gas monta al superficie del fluido que alora tende a separar los le unes ab le alteres. Un parte del interfacie inter le libere gas intra le peritoneo e le pariete intestinal se trova assi in position parallel al fasce de radios roentgen, e le contrasto deveni evidente in le radiogramma.

Un altere constatation de interesse, observate in un patiente e in duo canes in que pneumoperitoneo habeva essite inducite, esseva le demonstration de un umbra que correspondeva in position e apparentia al ligamento falciforme.

Concentrated Hypaque Sodium for Angiocardiography

Preliminary Report[1]

CHARLES FADEM, M.D., and HAROLD A. LYONS, M.D.

THE IMPORTANCE OF angiocardiography as a diagnostic procedure in cardiac and pulmonary diseases has already been established. As with any method of diagnosis, freedom from hazard to the patient is one of the prime factors to be taken into consideration before use of the procedure is undertaken. The injection of contrast material accounts almost entirely for the reactions occurring in angiocardiography. The present study is concerned with evaluating a newer medium, Hypaque-M, 90 per cent.

CHARACTERISTICS OF THE MEDIUM

Hypaque-M, 90 per cent,[2] is a mixture of the sodium salt and the n-methylglucamine salt of 3,5-diacetamido-2,4,6-triiodobenzoic acid in a combination of 30 and 60 per cent weight per volume, respectively (1). It is a water-soluble, white crystalline solid containing 59.8 per cent iodine. The diatrizoic acid from which the components of the solution are derived is chemically related to other contrast media such as Urokon (sodium acetrizoate). The product must be warmed to obtain a completely clear solution just prior to use. At room temperature, or if the solution is chilled, the salt precipitates out.

The free iodine content of the 90 per cent Hypaque is approximately the same as that of a 70 per cent solution of sodium acetrizoate. The roentgenographic contrast obtained with the 90 per cent solution is superior to that obtained with a 50 per cent solution for angiocardiography.

METHODS AND MATERIALS

A total of 38 injections were performed in 23 patients, 15 patients having two consecutive injections for the purpose of obtaining two necessary views. Eight patients had a single injection. There were 15 males and 8 females in the series. The youngest patient was seventeen and the oldest sixty-nine years of age. The dose of the contrast medium was 45 to 50 c.c.

Angiocardiographic studies were done with the Sanchez-Perez unit, with the patients in the sitting position (2), without preliminary medication or anesthesia. The procedure was carefully explained and reassurance given to each patient. Both of these measures were very effective in reducing anxiety and apprehension. Abstinence from food for at least four hours was the only prerequisite. The arm chosen for injection was splinted and then prepared with a tincture of Merthiolate. A tiny stab wound incision was made through the locally anesthetized skin overlying the median basilic vein, and a 12-gauge Robb-Steinberg needle was introduced directly into the vein. In a few patients, almost all females, the vein had to be exposed. The needle was anchored securely to the skin with a strip of tape and the patient placed in the desired position for the requirements of the study. Fifty to 100 c.c. of normal saline was rapidly injected to ensure correct placement of the needle. Two cubic centimeters of 90 per cent Hypaque was then injected into the venous needle as a test dose and the patient was instructed to practice breath holding in preparation for the actual study. If no reaction occurred —and none did—the full dose was rapidly injected within less than two seconds. Immediately following the roentgen exposures, 100 c.c. of saline was rapidly injected to "wash out" the Hypaque to reduce the likelihood of a chemical phlebitis.

In our experience with over 1,500 angio-

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[2] Hypaque-M, 90 per cent, was kindly supplied by Mr. Edward E. Radigan of the Winthrop Laboratories.

cardiographic studies, no reaction requiring emergency methods has ever occurred. In none of the patients receiving Hypaque was any reaction noted either from the test dose or the subsequent injection. In patients who received two injections during one examination period, fifteen minutes was allowed between injections. During this interval the wet films of the first angiocardiographic study were briefly reviewed. This procedure was helpful in aiding us to decide upon the best position for the next injection. Upon completion of the study, the needle was removed, pressure was exerted on the site of entry for five minutes, and a pressure dressing was applied. Sutures were never required for the stab wound. The patients were then returned to their wards or went home (as some were out-patients).

RESULTS

The following diagnoses were established with the aid of angiocardiography:

Pulmonary Diseases
- Bronchogenic carcinoma
- Idiopathic pulmonary fibrosis
- Tuberculosis

Acquired Cardiac Diseases
- Subendocardial fibroelastosis
- Tuberculous pericardial effusion
- Mitral stenosis
- Hypertensive cardiovascular disease
- Aortic arch aneurysm
- Coronary sinus aneurysm
- Cor pulmonale

Congenital Cardiac Diseases
- Tetralogy of Fallot
- Eisenmenger syndrome
- Valvular pulmonic stenosis
- Interatrial septal defect
- Coarctation of the aorta
- Dilatation of the pulmonary artery

In 3 patients there was combined disease; mitral stenosis and coronary sinus aneurysm, interatrial septal defect and cor pulmonale, and pulmonary tuberculosis with pericardial effusion. The anatomic lesions *per se* did not seem to predispose to or in any way affect the number or type of the side-reactions. In the presence of a right-to-left shunt, there was an earlier appearance of the side-reactions. With a prolonged circulation time there was a delay in their appearance.

It is difficult to analyze reactions which are subjective in nature. In patients who are alert, and perhaps apprehensive and influenced by a sudden rapid injection, subjective sensations may be greatly modified. Yet one must rely upon them as the only method for evaluation, except for reactions that can be objectively recorded by the physician. The great majority of the side-reactions were subjective in nature. Table I summarizes these and compares them with observation in a similar unselected group of patients receiving another medium. In assessing small groups, definite conclusions are unwarranted. In the opinion of experienced observers, however, 90 per cent Hypaque caused milder and fewer reactions than the other medium. Two patients who previously had received 70 per cent Urokon volunteered that Hypaque was milder.

TABLE I: COMPARISON OF REACTIONS WITH 70 PER CENT UROKON AND 90 PER CENT HYPAQUE

Reaction	70% Urokon	90% Hypaque
Heat or flush	36 (94%)	34 (89%)
Nausea	6 (15%)	3 (8%)
Vomiting	5 (13%)	2 (5%)
Headache	5 (13%)	5 (13%)
Dizziness	3 (8%)	0
Urticaria	3 (8%)	3 (8%)
Arm pain	6 (15%)	2 (5%)
Arrhythmia	0	0
Cough	1 (3%)	0
Dyspnea	1 (3%)	0
Thrombophlebitis	3 (8%)	0
Syncope	0	0
Shock	0	0

Patients frequently exhibited multiple side-effects. Two patients experienced sensations of heat and nausea as well as vomiting, headache, and urticaria. The two cases of local arm pain were of short duration and were most likely due to venous spasm. There were no episodes of thrombophlebitis in the group receiving Hypaque. More serious complications, such as arrhythmias, dyspnea, cough, syncope, and shock were not witnessed. In no patient did any of the side-effects persist longer than five to ten minutes except

for the urticaria. This was spotty in distribution, occurring almost entirely over the face and shoulders, and subsided in about an hour. The rather prompt disappearance of all reactions was gratifying both to the patients and the observers.

Two unusual reactions were noted. In 1 patient generalized pruritus developed without any skin lesions. This persisted about fifteen minutes and spontaneously subsided. Another patient complained of severe transient localized rectal burning, at the site of previously unknown internal hemorrhoids.

Although these mild reactions were frequent in the first study, a second injection was not deferred when another view was felt to be required. The second injection was always well tolerated. Reactions differed little from those experienced with the first injection. Two patients stated that the second injection was "milder" than the first. None found the reactions more intense than with the first injection.

Reactions occurring during angiocardiography are expected and are usually mild (3). Our observations are similar to those of Finby, Poker, and Evans (4). In neither our study nor theirs were there serious side-effects. Angiography of the coronary arteries by rapid injection of 90 per cent Hypaque through a cardiac catheter into the aorta was well tolerated by 7 experimental dogs (5). In excretory urography, 50 per cent Hypaque was found not only to be satisfactory, but in many ways to be superior to other agents (6, 7). The side-effects reported were similar to those in rapid intravenous angiography but certainly less intense and less frequent, probably because of the smaller dose, slowness of injection, and lesser concentration.

Radiographically there was satisfactory visualization of the cardiac chambers, great vessels, and pulmonary structures with the use of 90 per cent Hypaque. Opacification of the upper abdominal aorta and its branches was achieved. In some patients, a flat plate of the abdomen was made after completion of the angiocardiographic study, and excellent pyelograms were obtained. It was our impression that 90 per cent Hypaque was superior to 70 per cent Urokon for visualization of the thoracic cardiac and vascular structures, especially for demonstration of the venous return and the left-sided circulation.

Even though there was a lowered incidence of mild reactions with 90 per cent Hypaque, it is not believed that the other media are to be completely discarded. Severe reactions, and those which may be fatal, are usually attributable to hypersensitivity rather than to the chemical substance. For this reason, repeat angiocardiographic studies performed at a later date are best done with a different medium. It is therefore helpful in angiocardiography to have a choice of satisfactory agents. Preference will, of course, be given to those substances provoking minimal or no immediate or delayed reactions and producing improved radiopacity. The properties of easy handling and absence of deterioration, which both Urokon and Hypaque possess, are further considerations for their choice.

SUMMARY

Ninety per cent Hypaque as a contrast substance for angiocardiography has proved to be a well tolerated agent, producing minimal toxic effects. The radiopacity achieved with its use may be superior to that with other media. Side-effects with this agent were found to be reduced in number and intensity as compared to those occurring in a similar series examined with another opaque medium.

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SUMMARIO IN INTERLINGUA

Le Uso De Concentrate Hypaque Natrium In Angiocardiographia: Reporto Preliminari

Hypaque de 90 pro cento como substantia de contrasto in angiocardiographia se ha monstrate un ben-tolerate agente que produce un minimo de effectos toxic. Le radio-opacitate obtenite per su uso es possibilemente superior a illo obtenite per altere substantias. Le effectos lateral in le caso de iste agente esseva inferior in numeros e in grado de intensitate in comparation con illos occurrente in un simile serie examinate per medio de un altere substantia opac.

Intercomparison of X-Ray Exposure Dose Using Victoreen Dose Meters at Various Energies, Particularly 22 Mevp[1]

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THE EXPRESSION OF tissue dose for quantum radiation at the various energies now available is usually based on ionization measurements of x-ray exposure dose. Among the many dose meters that might be employed, the Victoreen condenser r-meter is most often used. An excellent calibration service for these meters has been offered by the National Bureau of Standards for a range of radiation qualities over a period of years. Not all Victoreen chambers, however, are referred to NBS for calibration, nor is calibration offered for all the radiation qualities now in use. Consequently, many installations may use Victoreen instruments as secondary standards without the advantage of calibration at a common reliable source. Furthermore, a variety of different calibration technics may be in use for the same quantum energy, the differences between which may be unknown.

The present paper describes an intercomparison between five institutions: namely, Memorial Hospital (New York), Presbyterian Hospital (New York), The Edward Mallinckrodt Institute of Radiology (St. Louis), The University of Illinois (Chicago), and M. D. Anderson Hospital (Houston, Texas), each of which either currently uses or has recently used 22 Mevp x-rays for clinical and biological purposes. The determination of exposure dose in each institution is based on a different calibration procedure, although each uses a Victoreen instrument. The calibration procedures were compared by first examining the factors associated with the methods of exposure and then using a satisfactory exposure procedure, making simultaneous comparisons. The intercomparisons were carried out in three groups, which are shown in Table I. Between the New York and St. Louis intercomparisons the opportunity was taken to compare the calibration factors determined by the National Bureau of Standards for the Victoreen instrument of M. D. Anderson Hospital at energies lower than 22 Mevp, notably for cobalt-60 γ-rays and for x-rays in the region of 180 to 250 kevp. The

TABLE I: INTERCOMPARISONS MADE

Intercomparison	Location and Date	Institution	Qualities Compared	Location of Beam
I	New York, February 1956	Memorial Hosp.	X-rays 1.8 mm. Cu h.v.l.	P.H.
		Presbyterian Hosp.	Cobalt-60 γ-rays	M.H.
		M. D. Anderson Hosp.	X-rays, 22 Mevp	P.H.
			Electrons, 20 Mev	M.H.
II	St. Louis, February 1956	M. D. Anderson Hosp.	X-rays, 22 Mevp	M. I.
		Mallinckrodt Inst.		
III	New York, June 1956	Memorial Hosp.	X-rays 2 mm. Cu h.v.l.	M.H.
		Univ. of Illinois	Cobalt-60 γ-rays	M.H.
			X-rays, 22 Mevp	P.H.
			Electrons, 20 Mev	M.H.

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TABLE II: ELECTROMETERS AND CHAMBERS USED IN INTERCOMPARISONS

Institution	Electrometer	25 r	100 r	250 r
Memorial	3239	95	*	95
Presbyterian	808	3326 A	3325	3324
M. D. Anderson	1665	50 (B)	188	* A
Mallinckrodt	1261	1261 A	1261 B	
Illinois	2471	2471	2471	3-1

* Indicates no designation by manufacturer.

actual electrometers and the chambers used in the intercomparisons are listed in Table II.

PERFORMANCE OF INTERCOMPARISON INSTRUMENTS

Since the Victoreen instruments of the M. D. Anderson Hospital and Memorial Hospital were used on two different occasions, the performance of these instruments is critical.

The M. D. Anderson Hospital Chamber and Electrometer: In normal use, the M. D. Anderson Hospital chambers are checked once a month for leakage and given a radium test, with a portable lead-shielded Lucite cylinder containing three radium sources totaling 4 mg. surrounding the chamber and providing a dose rate of about 0.5 r per minute. The voltage sensitivity of the electrometer is also checked regularly with a potentiometer. Electrometer sensitivity tests were made in Houston before the intercomparison and again in New York, Washington, and subsequently in Houston again. These showed that the electrometer sensitivity over the range from zero to full scale did not vary by a maximum of more than 0.5 per cent. The radium tests on the three chambers (25 r, 100 r, and 250 r) used in the intercomparison have been carried on for some time. Tests on the 25-r chamber show a maximum change of no more than ± 1 per cent extending over many months. The radium tests for 100-r and 250-r chambers are less satisfactory; variations of 2 per cent occurred during the period of these calibrations. Wider variations have been observed at other times. These tests are less satisfactory for the larger denomination chambers, partly perhaps because of their smaller size. In more recent constancy checks, the practice has been to test the 25-r chamber on radium and determine the ratios of the 100-r and 250-r chambers to it, with x-rays. Leakage tests were conducted on each occasion on which the chambers were used and, although small leakages were observed in some instances, the effect was so slight that no correction was necessary for this during the short exposures used in the intercomparison procedures.

As an indication of the performance of the electrometer and chambers, it is of interest to compare the calibrations of the M. D. Anderson Hospital chambers and electrometers made by the National Bureau of Standards. The averages of calibrations performed in September 1953 and November 1955 are compared with the correction factors determined in February 1956 for the same chambers and three different qualities in Table III. It may be noted that in the case of cobalt 60 the bracketed values represent those derived by NBS when the chamber is fully exposed in the beam.

In normal calibration procedures at the M. D. Anderson Hospital, the chamber is used with only half the stem irradiated in order to avoid some of the stem leakage which inevitably occurs. The correction factor for the 25-r chamber is 1.5 per cent greater under these circumstances, and the correction factors in brackets for the 100 r and the 250 r chambers are derived from the half-stem value by direct comparison on the cobalt-60 beam at M. D. Anderson Hospital.

Memorial Hospital Chamber and Electrometer: The chambers at Memorial Hospital are checked regularly once a month with a radium standard, in a procedure similar to that already described for the M. D. Anderson Hospital equipment. Their radium standard contains 50 mg. of radium and provides a dose rate of 1.6 r/min. The unit is designed to provide

TABLE III: NBS CALIBRATIONS FOR M. D. ANDERSON ELECTROMETER AND CHAMBERS

Date	Qualities	25 r B (50) Chamber	100 r (188) Chamber	250 r (A) Chamber
September 1953 and November 1955 (average)	X-ray, 1.2 mm. Cu h.v.l.	0.98	0.97	
	X-ray, 2.1 mm. Cu h.v.l.	1.00	0.98	0.99
	Cobalt-60 γ-rays			
	Whole stem	1.10		
	Half stem		[1.03]	
February 1956	X-ray, 1.2 mm. Cu h.v.l.	0.98	0.98	1.01
	X-ray, 2.1 mm. Cu h.v.l.	1.00	1.00	1.01
	Cobalt-60 γ-rays			
	Whole stem	1.09		
	Half stem	[1.11]	[1.02]	[1.02]

Notes: Bracketed values were derived on M. D. Anderson cobalt-60 beam irradiating half stem only.
The results of calibrations in September 1953 and November 1955 were averaged because neither was uncomplicated. September 1953 calibrations were made on another electrometer and chamber set, and the November 1955 calibrations had to be amended by 4 per cent due to change in electrometer sensitivity (measured) on return from NBS.

TABLE IV: CALIBRATION PROCEDURE FOR 22-MEVP X-RAYS
(Field 10 × 10 cm.; 80 cm. T.S.D. in all cases)

Institution	Lucite Block		Lucite in Front of Chamber	Chamber	Factor (NBS)	Qualities
Memorial	Square	8 cm.	3.3 cm.	25 r	1.08	2 mm. Cu h.v.l.
Presbyterian	Square	9.5 cm.	3.9 cm.	100 r	1.04	2 mm. Cu h.v.l.
		11.5 cm.	4.9 cm.			
M. D. Anderson	Cylindrical	9.5 cm.	3.9 cm.	100 r	(1.03)	Cobalt-60 γ-rays
Mallinckrodt	Cylindrical	9.5 cm.	3.9 cm.	100 r	No correction factor	
Illinois	Square	8 cm.	3.3 cm.	25 r	No correction factor*	

* During an interval (Fall 1952–Fall 1956) a correction factor of unity was applied to the Victoreen chambers of the University of Illinois which was later found to be erroneous.

relatively uniform irradiation over the thimble volume. Electrometer sensitivity tests are also made monthly. Repeated calibrations made at NBS indicate that no unexpected changes greater than ± 1 per cent have occurred.

CALIBRATION PROCEDURES FOR 22-MEVP X-RAYS

The calibration procedures for 22-Mevp x-rays used at the five different institutions at the time of this intercomparison are listed in Table IV. It will be noted that the main differences are in the type of chamber used and in the dimensions and shape of the Lucite blocks employed, together with the correction factor applied for converting the reading to exposure dose.

INTERCOMPARISON OF DIFFERENT TYPES OF CALIBRATION BLOCK

At the M. D. Anderson Hospital, the calibration block most frequently used is a cylinder of Lucite made up according to specifications recommended by the Allis-Chalmers Company. This cylinder is 9.5 cm. in diameter, with a chamber mounted in the center providing about 3.9 cm. Lucite between the surface exposed to the beam and the surface of the chamber. However, a square block of 11.5 cm. on each side is recommended by NBS *Handbook 55* as suitable for x-rays between 10 and 50 Mevp. Consequently, a number of comparisons were first made with a cylindrical 9.5-cm. block, a square 9.5-cm. block, a square 11.5-cm. block, and a square 11.5-cm. block with three chamber positions permitting simultaneous exposures. The results showed that the maximum difference between any two of these blocks was 0.5 per cent and that the overall difference between all blocks probably does not exceed 1 per cent. Consequently, it is safe to assume that, in the calibration procedures adopted by the five institutions, differences in blocks, whether cylindrical

or square, within the dimensions quoted, are not likely to give rise to serious errors. Since the "three-chamber" block agrees so closely with the others, it was used in the intercomparisons in New York and St. Louis.

INTERCOMPARISON TECHNICS

22-Mevp X-Rays: The three-chamber block which is shown in Figure 1 was used in intercomparisons I and II and it was also used in establishing chamber ratios at the M. D. Anderson Hospital. The procedure is to place each chamber in one of the block positions, expose, and then rotate the chambers cyclically until each has been exposed in each position at least twice. Adding these results eliminates the effect of output variations. The individual block positions will give identical exposure doses only if the beam is flat and all other conditions are constant. In the 22-Mevp x-ray beams of both Presbyterian Hospital and M. D. Anderson Hospital, the side positions varied by about ±2 per cent from the central position. (The device could therefore actually be used to check beam flatness.) In intercomparison I, the 25-r, 100-r, and 250-r chambers from the three institutions were compared in groups with one another. Then 25-r and 100-r chambers were compared against each other, and 100-r and 250-r chambers were compared against each other, making a total of five series of measurements, each of which was run twice. Good agreement and consistent results were obtained.

A similar series was conducted in intercomparison III for 25-r chambers only, with a two-chamber block permitting simultaneous exposure with 4.5 cm. of Lucite in front of the chamber.

20-Mev Electrons: Intercomparisons involving 20-Mev electrons (I and III) were made at Memorial Hospital. A block of polystyrene, normally employed for the exposure of mice, was used for successive exposures of the chambers, each of which was embedded at a depth of 1.5 cm. in the polystyrene. The integrating circuit at Memorial Hospital is an improved circuit,

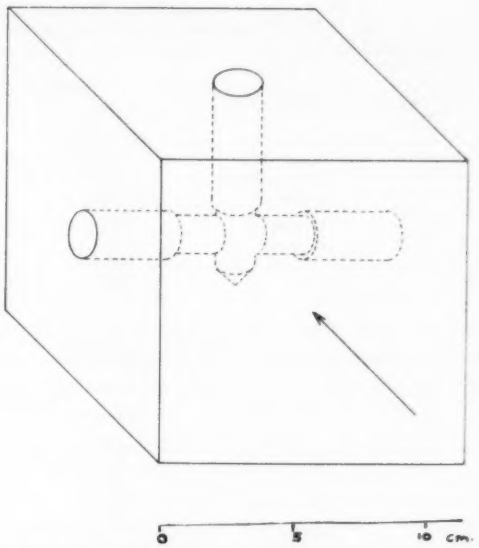

Fig. 1. Block used for intercomparisons I and II. This block of Lucite permits three Victoreen chambers to be exposed simultaneously in a plane perpendicular to the x-ray beam.

the performance of which is well known and very reliable. This integrator was therefore relied upon for comparing one chamber with another.

X-Rays: Intercomparison I was conduted at Presbyterian Hospital with x-rays at 210 kevp filtered with 1.1 mm. Cu + 0.5 mm. Al, yielding an h.v.l. of 1.8 mm. Cu. The chambers were mounted on three holders, at 120° to one another, and were exposed to air. They were rotated cyclically and two series were run following the procedure with 22-Mevp x-rays, and again the series were found in good agreement.

Intercomparison III was conducted at Memorial Hospital with 250-kevp constant-potential x-rays, h.v.l. 2 mm. Cu. The chambers were centered in the x-ray beam and exposed simultaneously in air.

Cobalt 60: For intercomparison I and III, the cobalt-60 exposures were conducted at Memorial Hospital, a fixed position of the chamber in air being used in which approximately half the stem of the chamber was exposed. The 25-r chambers were exposed successively in this position and 100-r chambers of Presbyterian and M. D.

TABLE V: RELATIVE EXPOSURE DOSE: X-RAYS
(I. 210 Kevp, h.v.l. 1.8 mm. Cu. III. 250 Kevp, h.v.l. 2 mm. Cu)

Inter-comparison	Institution	Chamber Range	Chamber Number	Relative Reading	NBS Factor	Relative Exposure Dose Estimate
I	Memorial	25 r	95	1.00	1.08	1.00
	Presbyterian	25 r	3326 A	1.024	1.05	1.00
	Anderson	25 r	50 (B)	1.07	1.00	0.99
III	Memorial	250 r	2603	1.00	1.08	1.00
	Illinois	25 r	2471	1.00	1.10	1.02
		100 r	2471	1.00	...	...
		250 r	2471	1.00	...	...

TABLE VI: RELATIVE EXPOSURE DOSE: COBALT-60 γ-RAYS

Inter-comparison	Institution	Chamber Range	Chamber Number	Relative Reading	NBS Factor (whole stem)	Relative Exposure Dose Estimate
I	Memorial	25 r	95	1.00	1.18	1.00
	Presbyterian	25 r	3326 A	1.048	1.13	1.00
	Anderson	25 r	50 (B)	1.071	1.10	1.00
III	Illinois	25 r	2471	1.04	1.15	1.01

Anderson Hospitals were also included. The relative sensitivity of other chambers has been derived in the individual institutions, with their own cobalt-60 beams.

RESULTS

For convenience, at all energies the reading of the 25-r Memorial Hospital chamber has been taken as 1.00. The results for the x-ray exposures are shown in Table V.

The results for the University of Illinois are for correction factors determined (November 1956) subsequent to the intercomparison (June 1956). The agreement is within ± 2 per cent, better than the accuracy claimed by NBS for their Victoreen calibrations.

The results for cobalt-60 γ-radiation are shown in Table VI. The correction factor for the University of Illinois chamber subsequent to the intercomparison was again determined in November 1956; the excellent agreement between these results needs no further comment.

The relative values for each of the chambers for 20-Mev electrons are shown in Table VII. These are of little significance for intercomparison purposes but enable the other institutions to make use of Memorial Hospital measurements on electrons if they should use electrons at a later date.

TABLE VII: RELATIVE READING: 20-MEV ELECTRONS
(15 × 15-cm. field at 80 cm. T.S.D.)

Inter-comparison	Institution	25-r Chamber	100-r Chamber	250-r Chamber
I	Memorial	1.00	1.04 (5)	1.06
	Presbyterian	1.04	1.03 (6)	1.04
	M. D. Anderson	1.08	1.12	1.13
III	Illinois	0.99	...	...

TABLE VIII: RELATIVE READING: 22-MEVP X-RAYS
(10 × 10-cm. field at 80 cm. T.S.D.)

Inter-comparison	Institution	25-r Chamber	100-r Chamber	250-r Chamber
I	Memorial	1.00	1.06	1.07
	Presbyterian	1.05	1.05	1.05
	M. D. Anderson	1.07	1.14	1.14
II	Mallinckrodt	0.98	1.05	
III	Illinois	0.98		

The most important group of results is that for 22-Mevp x-rays, the relative readings for which are shown in Table VIII. This table provides the basic information for any chamber included to be used for the measurement of 22-Mevp x-rays and expressed relative to any one of the others.

The results set forth in this table may

TABLE IX: ESTIMATED RELATIVE EXPOSURE DOSE: 22-MEVP X-RAYS

Inter-comparison	Institution	Chamber	Relative Reading	Correction Factor	Relative Exposure Dose Estimate
I	Memorial	25 r	1.00	1.08	1.00
	Presbyterian	100 r	1.05	1.04	1.01
	M. D. Anderson	100 r	1.14	1.03	1.09
II	Mallinckrodt	100 r	1.05	None applied	0.97
III	Illinois,* November 1956	25 r	0.98	None*	0.91
				1.10	1.00

* See footnote Table IV.

now be combined with the calibration information of Table IV to obtain the estimate of relative exposure dose (called "roentgens") for 22-Mevp x-rays used in each of the institutions. This is shown in Table IX, and indicates that differences in the method of applying correction factors lead to different values for the exposure dose. During a recent interval, a variation of nearly 20 per cent existed between the University of Illinois on the one hand, and the M. D. Anderson Hospital on the other (see footnote, Table IV). Consequently, one should appreciate, when quoting clinical and biological results which depend on these measurements, that these differences exist, or have existed.

As a result of these intercomparisons, it is now possible to compare relative estimates of the exposure dose and thus to compare what are nominally called "roentgens" in each of the institutions.

CONVERSION OF EXPOSURE DOSE MEASUREMENTS TO ABSORBED DOSE ESTIMATES FOR 22-MEVP X-RAYS

It would be much better if each of the institutions concerned were in a position to use an absorbed dose estimate (in rads) rather than an *arbitrary* estimate of exposure dose. This would be possible if direct measurements of the energy absorbed under the same circumstances were available at this energy. This is not the case, however, at the present time. If the ionization measurements were carried out, calculations could be made of the energy absorbed provided polarization and all other factors were taken into account, and this might be an alternative to direct calorimetric measurement. Ionization measurements have been made in polystyrene at Memorial Hospital, and by using these measurements it is possible to obtain an approximation to the likely conversion factors for exposure dose to absorbed dose. The measurements made by Laughlin (1) indicate that at 4.65 cm. depth in polystyrene there is *0.985 esu* per cubic centimeter per nominal Memorial "roentgen." The nominal Memorial roentgen is the corrected reading of their 25-r chamber (No. 95) in a Lucite block with the 250-kevp correction at 2 mm. Cu h.v.l. (1.08), as outlined in the previous tables. Thus this is represented by the relative value 1.00 in Table VIII. Data describing the relation between cavity ionization and absorbed dose (1) indicate that in polystyrene exposed to 22-Mevp x-rays the absorbed dose (in rads) is 0.94 times the cavity ionization in esu per cubic centimeter of air. Consequently, in order to translate the estimate of exposure dose contained in Table VIII into absorbed dose in polystyrene measured in rads, Memorial would multiply by 0.93, Presbyterian by 0.92, M. D. Anderson by 0.85, and the others similarly.

A measure of the energy absorbed in polystyrene is not, however, of much value to the radiologist or the radiobiologist. He requires the energy absorbed in water or tissue. The ratio of the absorbed dose in water and in polystyrene should be the ratio of their effective absorption coefficients obtained by weighting the absorption as a function of energy for these materials with the intensity spectrum of the betatron. This calculated ratio is 1.07, which results in a conversion factor of 0.99.

TABLE X: TENTATIVE CONVERSION FACTORS, ESTIMATED EXPOSURE DOSE TO ABSORBED DOSE: 22-MEVP X-RAYS

Institution	Chamber	Relative Reading	Correction Factor (Reading to "Roentgens")	Rads per "Roentgen"	Reading to Rads
Memorial	25	1.00	1.08	0.99	1.07
	100	1.06			1.01
	250	1.07			1.00
Presbyterian	25	1.05			1.02
	100	1.05	1.04	0.98	1.02
	250	1.05			1.02
M. D. Anderson	25	1.07			1.00
	100	1.14	1.03	0.91	0.94
	250	1.14			0.94
Mallinckrodt	25	0.98			1.09
	100	1.05		1.02	1.02
Illinois	25	0.98	1.10	0.99	1.09

With this assumption, it is possible to use the exposure dose rate comparison in Table IX to provide figures for the conversion of exposure dose to absorbed dose. This is summarized in Table X. In this table are indicated the relative readings for each of the chambers, the correction factor normally applied for the chamber regularly used for calibration, the rads per nominal roentgen (the factor needed to convert nominal roentgens to rads), and the factor needed to convert the actual chamber reading to rads. At this stage each of the last three columns in Table X is necessary, since most of the previous clinical and biological data will have been put forth in roentgens, whereas at some later date we will want to correct directly from the Victoreen chamber reading to the absorbed dose in rads and avoid the unnecessary step of expressing the dose in nominal roentgens.

It may be noted that the assumption has been made that the contribution of the fast neutrons to the dose rate is negligible. The dose produced by the fast neutrons in the x-ray beam has been calculated (2) for the case of a four-portal irradiation. The tumor dose (in rems) produced by the neutrons amounted to 1 per cent of the total tumor dose with a relative biological effectiveness (RBE) of 10 for the fast neutrons. Calculations on the basis of known photo-disintegration cross sections also indicate a negligible dose contribution from nuclear reactions.

A determination of the absorbed dose rate relative to the nominal exposure dose is being made with the betatron at Presbyterian Hospital. The measurements are being carried out with a tissue-equivalent chamber (3) and the results will be substantially independent of any neutron contamination of the x-ray beam.

Quite clearly, much more experimental work needs to be done before the relationship between exposure dose and absorbed dose at high energies, such as 22 Mevp, can be considered finally established. It is hoped that the results of this study will not only enable clinical results with 22-Mevp x-rays to be compared more significantly between the institutions concerned, but will also provide a better basis for the dosimetry of biological experiments designed to determine the RBE of this radiation.

SUMMARY

Intercomparisons of the exposure dose measurement procedures employed in five institutions which use or have recently used 22-Mevp x-rays for clinical and biological purposes have been conducted with Victoreen condenser chambers. Constancy checks on the Victoreen instruments involved were conducted using radium checks and leak tests on the chambers and voltage sensitivity tests on the electrometer. No change in electrometers and chambers was noted throughout the intercomparison.

The institutions concerned were: Memorial Hospital (New York), Presbyterian

Hospital (New York), M. D. Anderson Hospital (Houston), The Edward Mallinckrodt Institute of Radiology (St. Louis), and the University of Illinois (Chicago). The results show that the various types of Lucite calibration block in use have little influence on the measurements, and their dimensions, within limits, are not critical. Differences arise, however, from the application of different correction factors. A considerable difference occurs between the M. D. Anderson Hospital, which applies the correction factor for cobalt-60 γ-radiation to its Victoreen chamber, and the Memorial and Presbyterian Hospitals, which use Victoreen correction factors for 200-kv radiation. The difference is about 8 per cent, the nominal roentgen at M. D. Anderson Hospital at this energy being smaller than the others. Mallinckrodt Institute and the University of Illinois applied no correction factor at the time of this intercomparison. In Mallinckrodt Institute the uncorrected Victoreen is fortuitously close to Memorial and Presbyterian Hospital calibrations but in the case of the University of Illinois a difference of 9 per cent arises, the University of Illinois being larger. A total difference of nearly 20 per cent therefore existed, at least temporarily, between the University of Illinois on the one hand and M. D. Anderson Hospital on the other. Since estimates of exposure dose are arbitrary at this energy, no one of the institutions named can be termed "correct." It is now possible, however, to compare these relative estimates of "nominal roentgens" that are frequently quoted in clinical and sometimes in biological work from these institutions.

Although information on absolute determinations of the conversion factors for exposure dose to absorbed dose at this energy is not very adequate, an effort has been made to determine tentative conversion factors using measurements and calculations due to Danzker and Laughlin (1).

During the intercomparisons, opportunity was also taken to compare the regular calibration procedures at lower energies, namely for cobalt-60 γ-rays and for standard radiation at about 2 mm. Cu h.v.l. Most of these procedures are based on correction factors resulting from calibrations at the National Bureau of Standards. In the case of the chambers used by Presbyterian Hospital, the calibration was performed by C. B. Braestrup, Director, Physics Service, New York City Department of Hospitals. The standardization procedures at this laboratory are frequently compared with those at NBS. Although the intercomparisons described do not check the absolute nature of the calibrations at NBS, they do provide a means of testing the secondary standardization procedures. The results show excellent agreement both for cobalt-60 γ-radiation and for x-radiation at 2 mm. Cu h.v.l.

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(*Pro le summario in interlingua, vider le pagina sequente*)

SUMMARIO IN INTERLINGUA

Intercomparation Del Doses De Exposition A Radios X Con Le Uso De Dosimetros Victoreen A Varie Energias, Specialmente 22 Mevp

Intercomparationes del methodos de mesuration del doses de exposition in cinque establimentos que usa o ha usate in tempores recente radios X a 22 Mevp pro objectivos clinic e biologic esseva executate per medio de cameras condensatori Victoreen.

Le establimentos esseva Hospital Memorial (New York), Hospital Presbyterian (New York), Hospital M. D. Anderson (Houston), le Instituto Radiologic Edward Mallinckrodt (St. Louis), e le Universitate Illinois (Chicago). Le resultatos monstra que le varie typos de blocos calibrational de Lucite que es in uso exerce pauc influentia super le mesurationes, e lor dimensiones—intra certe limites—non es critic. Tamen, differentias resulta del application de differente factores de correction. Un differentia considerabile occurre inter le Hospital M. D. Anderson, que applica le factor de correction pro radiation gamma de cobalt-60 a su camera Victoreen. e le Hospitales Memorial e Presbyterian, que usa factores de correction de Victoreen pro radiation a 200 kv. Le differentia amonta a circa 8 pro cento. A iste energia le roentgen nominal al Hospital M. D. Anderson es plus micre que le alteres. Al tempore de iste intercomparation, le Instituto Mallinckrodt e le Universitate Illinois non applicava ulle factor de correction. Al Instituto Mallinckrodt, le non-corrigite Victoreen es fortuitemente vicin al calibrationes del Hospitales Memorial e Presbyterian, sed in le caso del Universitate Illinois il occurre un differentia de 9 pro cento, con le Universitate Illinois excedente le alteres. Assi il existeva, al minus temporarimente, un differentia de quasi 20 pro cento inter le Universitate Illinois de un latere e le Hospital M. D. Anderson del altere. Proque estimationes del dose de exposition es arbitrari a iste energia, nulle del establimentos pote esser designate como "correcte." Tamen, il es nunc possibile comparar iste estimationes relative de "roentgen nominal" que es frequentemente citate in reportos clinic e a vices in reportos biologic que es publicate per ille establimentos.

In le curso del intercomparationes, le opportunitate esseva usate de comparar etiam le regular methodos de calibration a energias plus basse, i.e., pro radios gamma de cobalt-60 e pro radiation standard a un medie valor de spissitate de circa 2 mm de Cu. Le majoritate de iste procedimentos es basate super factores de correction que resulta ab calibrationes al Bureau National de Standards. Le resultatos demonstra excellente grados de congruentia tanto pro radiation gamma de cobalt-60 como etiam pro roentgenoradiation a un medie valor de spissitate de 2 mm de Cu.

DISCUSSION

Gail D. Adams, Ph.D. (San Francisco, Calif.): I would just like to report that I visited the M. D. Anderson Hospital in June 1956 and brought along one of our chargers with a few thimbles. While at Anderson, intercomparisons were made with their thimbles and thus, in effect, an NBS calibration was transferred from their set to ours, and for several radiation qualities. Just recently I have taken the same set to the Bureau to receive calibrations covering the same quality range. Thus, our instrument has participated in a calibration triangle. The average difference between correction factors obtained at Anderson and directly at the Bureau is less than 1 per cent. It is this consistency of the Bureau which is worth noting.

Miss Jenks: How does the calibration made by the Victoreen Company itself compare with the calibration of the Bureau of Standards? They do a goodly number of the calibrations.

Dr. Sinclair: I don't know if anybody else can answer that question. I can't. We have consistently avoided Victoreen calibration in our own work simply because we feel that one common reliable source is quite sufficient and we have based our instruments on calibrations made at the Bureau

of Standards. I personally feel that a lot of other people ought to do the same, but I can't say what the difference is between NBS and *any* other source of calibration.

H. H. Rossi, Ph.D. (New York, N. Y.): I would like to point out that these measurements bear on the numerous studies that have been performed to determine the relative biological effectiveness of betatron x-rays as compared with conventional 250-kv radiation. Even for the same biological effects, values ranging anywhere from 0.85 to 1.0 have been reported in the literature. In view of the varying calibration factors mentioned by Dr. Sinclair, it would seem that at least part of the reported variations in RBE may be due to different physical doses.

Dr. Sinclair: This, of course, was the whole point of these measurements, and I hope it is clear to the audience that the objective here is not to test the Bureau of Standards, although that happened to be incidental to this comparison. I think it turned out extremely well and, if we had had a Bureau of Standards calibration available at 22 million volts, I am sure we would have taken our Victoreen condenser r meter to the Bureau of Standards and obtained their calibration rather than adopting this particular procedure. However, to return to Dr. Rossi's point, I agree that assumptions cannot be made about RBE's unless the dose is established.

Rosalyn S. Yalow, Ph.D. (New York, N. Y.): If the Anderson Hospital had applied a 200-kv correction instead of the cobalt correction, would they have agreed better with Memorial?

Dr. Sinclair: Yes, they would. If we had used the 25-r chamber and applied the correction for h.v.l. 1.3 mm. copper, we would have agreed within 1 per cent.

Dr. Yalow: So you would then have a common basis.

Dr. Sinclair: This is not a difference of measurement. This is a difference in the corrections believed to be necessary to that measurement after you have made it. The intercomparison was undertaken in order to establish the relationship of these estimates to one another.

True Tangential X-Ray Treatment of Small Skin Lesions[1]

JULIUS G. BÁRON, M.D.

X-RAY THERAPISTS have become increasingly conscious of possible damage to healthy tissue surrounding an area under treatment. Although such damage may be perfectly justifiable in case of a malignant lesion, this is not necessarily true in benign conditions. In fact, many radiologists are inclined to avoid such treatments altogether. At least, there is a trend not to expose young individuals to large doses of irradiation for benign disease.

A goal of therapy is to restrict exposure to the area of involvement. Although this is not feasible in most instances, it can be very nearly achieved in some patients who have protruding skin lesions, by the use of tangential exposures. Unfortunately, many skin lesions are not prominent enough to make tangential exposure possible. The device to be described here permits tangential irradiation even when the lesion to be treated is level with the skin.

Figure 1 shows the longitudinal section of a brass cone, the cross section of which is a 4 × 4 cm. square. The length of the cone is 37 cm. A-B is the base of the cone. C-D is an aluminum wall 0.5 mm. thick. G-H is an opening covered by a glass plate (P) so that it is air-tight. I-J is a smaller opening from which a metal tube (T) originates. This is connected to a vacuum pump and a manometer by vacuum rubber tubing. M-N is the endwall of the cone, lined with lead. E-F is a round hole of variable size which can be adjusted to fit the lesion to be treated. Inserts to narrow this opening have diameters of 1 to 2.5 cm. When in place, they form an air-tight seal around the aperture.

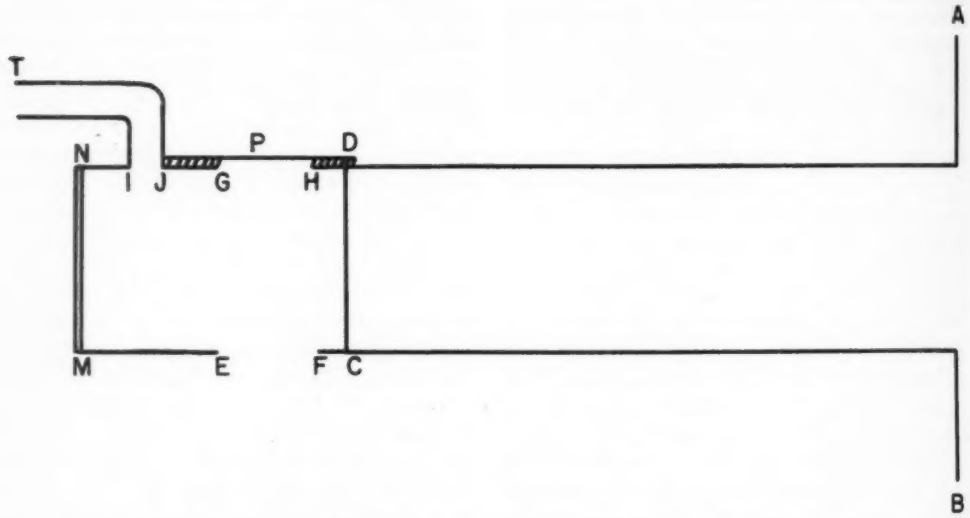

Fig. 1. Longitudinal section of device designed for tangential irradiation of small skin lesions.

The skin to be irradiated is fitted properly

[1] From the Radiology Service, Veterans Administration Hospital, Iowa City, Iowa. Accepted for publication in November 1957.

into the hole E-F so that the chamber C-D-N-M is air-tight. The pressure within this compartment of the cone can be lowered by operating the pump connected with T. When the pressure (observed on the manometer) falls to about 150 mm. Hg, the lesion is sucked into the air-tight compartment of the cone. There it protrudes above the plane M-E-F-C and can be inspected through the glass wall P with the aid of a flashlight. In order to keep the vacuum at the optimal level, the pump must be operated constantly, since minor leakage of air at the contact of the skin and of the wall of the cone cannot otherwise be avoided. Such leakage can be minimized by coating the area to be treated with a simple lubricating ointment.

With this device, only scattered radiation can reach the tissues underlying the lesion. Distribution of dose is almost uniform, even with a single irradiation because of the thinness of the irradiated tissue. If multiple treatments are necessary, the x-ray beam can be directed to different sides of the lesion to insure more uniform distribution of the dose.

The suction usually causes ecchymoses of moderate size in the surrounding skin. If treatment is prolonged, the suction may also cause pain. Six minutes has been found to be an approximate upper limit of duration for a single treatment. Local swelling and skin reaction may cause some slight discomfort after the irradiation, but this is short-lived, as shown in preliminary studies and does not influence the effect of irradiation.

After experiments on the skin of volunteers, it was found that a single skin dose of 300 r (110 kv, 1 mm. Al filter) had no visible after-effects and could be repeated daily several times. The volume dose is, of course, negligible.

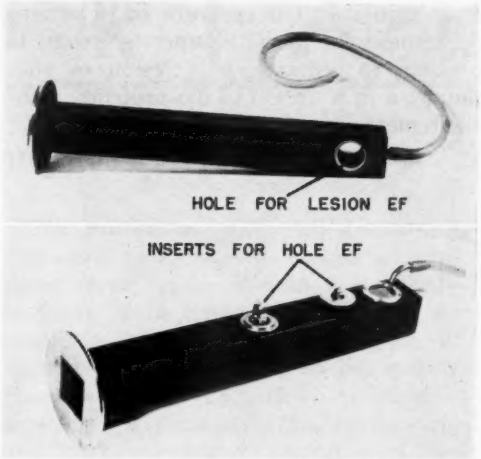

Fig. 2. Photograph of device for tangential irradiation.

In actual therapy, small skin lesions, *e.g.*, leukemic skin infiltrations, warts, and birthmarks, have been treated with satisfactory results. No curative treatment of skin cancer was attempted. It is believed that cancerous lesions need more penetrating irradiation and here the reduction of volume dose is less important.

SUMMARY

A device is described by which small skin lesions can be treated by x-rays directed tangentially, thus minimizing volume dose and protecting underlying tissues. The method is not advocated for the curative treatment of skin cancer.

VA Hospital
Iowa City, Iowa

SUMMARIO IN INTERLINGUA

Roentgenotherapia Genuinmente Tangential Pro Micre Lesiones Cutanee

Es describite un dispositivo que permitte le roentgeno-irradiation tangential de micre lesiones cutanee, resultante in un minimisation del dosage de volumine e in le protection del histos subjacente. Illo es applicabile mesmo quando le lesion a tractar se trova a nivello con le pelle.

Le dispositivo consiste de un cono de metallo, con un camera a un de su extremitates in le qual le pression aeree pote

esser regulate. Un apertura in le pariete del camera es placiate super le lesion, le pression es reducite, e le lesion es suctionate a in le tubo ubi illo protrude sufficientemente pro le irradiation tangential.

Leucemic infiltrationes cutanee, verrucas, e nevos ha essite tractate satisfactorimente per iste methodo. Illo non es recommendate pro le tractamento curative de cancere del pelle.

EDITORIAL

Radiotherapy at the Community Hospital Level

The community hospital assumes a major role in the diagnosis, prevention, and treatment of disease. Specialties heretofore concentrated in metropolitan centers have reached maturity in suburban areas. Thoracic surgery and neurosurgery, to mention two facets of a general surgical practice, are now sending many modernly trained practitioners to meet the demands of an ever expanding peripheral population. It is no longer fashionable, nor is it necessary, to travel great distances for specialty consultation. The young specialists occupy an integral and positive niche in the consulting room of the smaller, well equipped voluntary hospital. Among these the radiologist has, from the start, assumed a major position. His contributions are legion and tinge every aspect of medical and surgical endeavor. He is often misunderstood, often maligned, but never considered expendable.

Radiotherapy has paid the penalty of the radiologist's unavoidable preoccupation with administrative and diagnostic problems—not that it has been done poorly, but it has, shall we say, led too sheltered a life. It needs to be brought more forcefully to the attention of the general practitioner and the surgeon, and perhaps even of the radiologist himself.

Radiotherapy includes, in addition to external roentgen irradiation, treatment by radium and the by-products of nuclear energy. As the pioneer was caught up in a maelstrom of diagnostic challenges, so today's radiologist finds himself in the labyrinth of an atomic age. It becomes clear that too much is demanded of one person. The attenuation of his curriculum into the far reaching environs of diagnosis, oncology, and radioisotopes makes room, as in the surgical specialties, for subspecialization.

The Europeans recognized separate disciplines of radiodiagnosis and radiotherapy many years ago. We in this country, however, have tended to look with suspicion on this dichotomy as being too disenfranchising. This is not to disparage the many workers in America who have literally given themselves to the empirical and later scientific formulation of basic therapeutic concepts. Our results in the management of cancer are evidence of their attainments. The point is that there is a tremendous demand for well trained radiotherapists, especially in the suburban or rural hospital.

Some will object that the smaller community cannot support or absorb the type of man who is interested in therapy. Others will say that supervoltage and megavoltage machines cannot be placed on a practical basis in suburban locales. Still others will hold that radium therapy should be left in the hands of the surgeon. Basically all of these critics might have been correct twenty years ago. Actually, the radiologist is the logical man to deal with such matters. His training includes pathology, basic radiation physics, the management of early and advanced cancer, and familiarity with x-rays, radium, and isotopes. He is often more conversant with the surgical approach to the cancer problem than his surgical confrere. He realizes full well that radiation and surgery are not competitive, and only through this realization may he best serve his patient. His is an exacting tool, requiring detailed preparation prior to its use and necessitating careful follow-up.

By and large the greatest amount of radium therapy is still being done under surgical auspices, particularly in gynecological cancer. This is a historic anomaly

and it can be said that only by default did the surgeon come into possession of this valuable tool. Radium has many advantages, among them delivery of a rather intense dose to a limited area, thus preserving a large amount of normal tissue. Unfortunately, it has been used in a haphazard manner. Rarely is the technic adjusted to a given clinical problem. It is apparent from the most cursory review of the literature of the past thirty years that the distribution, loading, and time patterns of radium therapy significantly affect results. It is with such matters that the radiotherapist is equipped to deal. Radiotherapy is a demanding taskmaster. It implies a basic knowledge of physics and radiation biology, a familiarity with the natural history or pathogenesis of the various types of cancer species, serious understanding of radiation technics, hazards, and complications.

The supervoltage trend is important and now fairly well understood. It is true that the majority of malignant diseases can be treated just as safely and just as well, from the point of view of survival, with conventional deep therapy apparatus. Once a program of big-league radiotherapy has been established, however, and the needs of the community are evaluated relative to patient load and the diseases to be treated, ultravoltage equipment should be added if in the best interest of the patients. There is no doubt that, for a specific group of cancers, *viz.*, those deeply situated in the lung or esophagus, and some pelvic lesions, this modality, while probably adding little to actual cure rate, will increase the sufferer's comfort immeasurably.

Treatment is not the giving of a "few shots of x-ray" or the application of "so many milligram-hours of radium." There are scientific and physiologic reasons for its use. It requires evaluation of the patient in terms of general physical condition, as well as consideration of the histologic type, extent, and location of the tumor. A choice must be made of x-ray, radium, or surgery, or a combination of these agents. Other factors come into play. How many portals will be used, and of what size; what time sequence will be followed; how will the filtration vary; what will the daily dose be? These are a few of the variables in the practice of radiotherapy. The patient's progress must be observed relative to undue reactions, complications, or supervening illnesses. His treatment is usually prolonged and often demanding. Intensive radiotherapy can be as sapping as major surgery. Supplementary measures in the way of blood transfusions, antibiotics, vitamins, and bed rest are often prescribed. The handling of the cancer patient with radium or roentgen rays is a full-time job, requiring close consultation with the surgical specialist and the medical service.

Whether cure or palliation is the goal, much depends on the patient's awareness of the weeks ahead and the referring physician's understanding and co-operation. Too few physicians have taken the time to acquaint themselves with this facet of medicine. Oftentimes, it is the fault of the radiologist, who neglects to explain in detail the treatment plan.

Finally, radiation sequelae are unique in that they are permanent. The acute skin and mucous membrane reactions are often unsightly and occasionally painful. More important is the later appearance of reactions and the general bodily response as reflected in bone marrow and gastrointestinal aberrations. Here the radiologist lays the groundwork for future success by education of his patients and associates.

It is beyond the scope of this presentation to enumerate patient situations susceptible of radiation management. Suffice it to say, that the radiotherapist will of necessity be required to bring to the attention of his staff, by lectures and the usual audiovisual technics, the manifold uses of ionizing radiation in the cure and palliation of malignant disease. This is not to say that he should recommend ionizing radiation indiscriminately, but rather that he should reorient his colleagues in modern day radiotherapeutic thought and practice.

FREDERICK W. O'BRIEN, JR., M.D.
27 Elm Street, Worcester, Mass.

ANNOUNCEMENTS AND BOOK REVIEWS

SIXTH INTER-AMERICAN CONGRESS OF RADIOLOGY

The preliminary program of the Sixth Inter-American Congress of Radiology to be held Nov. 2–8, 1958, in Lima, Peru, under the presidency of Dr. Oscar Soto has appeared. The two main themes of the Congress are (1) Supervoltage and Kinetic Therapy, and (2) Tomography. Provision is also made for the presentation of papers on other phases of diagnosis, radiotherapy, radiobiology and radiophysics. Registration is scheduled for Saturday, Nov. 1, and Sunday, Nov. 2, with the opening ceremony at 11 A.M. on Sunday.

There will be three classes of members. For the first class, consisting of Full Members, *i.e.*, physicians specializing in any branch of radiology, the fee will be $35 American before May 1, 1958, and $45 thereafter. The second class, Scientific Associated Members, includes physicists, radiobiologists, radiochemists, technicians, and personnel of x-ray, radium, and radioisotope industries. For these the fee will be $20 American before May 1, and $30 afterward. The third class, Social Associated Members, is made up of wives and relatives of Full Members and Scientific Associated Members, and the fee is $20 American.

The program includes scientific sessions, refresher courses, scientific and commercial exhibits, visits to local hospitals, and social activities. In addition, there is a generous allowance of free time.

The Arne Jensen Travel Agency, 9034 Sunset Blvd., Hollywood 46, Calif., is the official agent of the Congress and will take care of reservations and transportation in close collaboration with the Executive Committee in Lima. This agency will arrange tours before and after the Congress to historical monuments and other places of interest.

AMERICAN RADIUM SOCIETY

At its fortieth annual meeting, the American Radium Society elected the following officers for the coming year: President, Milford D. Schulz, M.D., Boston, Mass.; President-Elect, Theodore R. Miller, M.D., New York, N. Y.; First Vice-President, Theodore P. Eberhard, M.D., Ann Arbor, Mich.; Second Vice-President, James F. Nolan, M.D., Los Angeles, Calif.; Secretary, Robert L. Brown, M.D., P.O. Box 459, Emory University, Ga.; Treasurer, Jesshill Love, M.D., Louisville, Ky.

The forty-first annual meeting will be held April 6–8, 1959, at The Homestead, Hot Springs, Va.

ATLANTA RADIOLOGICAL SOCIETY

The Atlanta (Ga.) Radiological Society recently elected the following new officers: President, Dr. Richard A. Elmer; Vice-President, Dr. J. Frank Walker; Secretary-Treasurer, Dr. J. L. Clements, Jr., 35 Linden Ave., N. E.

ROCKY MOUNTAIN CANCER CONFERENCE

The Twelfth Annual Rocky Mountain Cancer Conference will be held July 9 and 10, 1958, in Denver, Colo., with headquarters at the Shirley-Savoy Hotel. The Chairman of the Cancer Conference Committee is Alexis E. Lubchenco, M.D., 835 Republic Bldg., Denver 2.

MAYO MEMORIAL LECTURE

The fourth annual W. J. and C. H. Mayo Memorial Lecture was given by Dr. Merrill C. Sosman, Emeritus Professor of Roentgenology in the Harvard Medical School, and Emeritus Roentgenologist-in-Chief of the Peter Bent Brigham Hospital, Boston, on March 29, 1958, at Carpenter Hall, Dartmouth College, Hanover, N. H. Dr. Sosman chose as his subject, "The Accuracy of X-Ray Diagnosis."

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

DR. W. C. RÖNTGEN. By OTTO GLASSER, Ph.D., F.A.C.R. (Assoc.), Holder of Röntgen-Honor-Plaque of the Röntgen-Museum in Remscheid-Lennep, 1951; Professor of Biophysics, Frank E. Bunts Educational Institute; Head, Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio. Second edition. A volume of 170 pages, with 14 illustrations. Published by Charles C Thomas, Springfield, Ill., 1958. Price $4.50.

ROENTGENOLOGY OF THE CHEST. Edited by COLEMAN B. RABIN, M.D., F.C.C.P., Attending Physician and Associate Radiologist for Chest Diseases, The Mount Sinai Hospital, New York City; Assistant Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University; Consultant Physician for Chest Diseases, Veterans Administration, Brooklyn Regional Office and East Orange Hospital and Beth El Hospital, Brooklyn, New York. Editorial Committee: Benjamin M. Gasul, M.D., Burgess L. Gordon, M.D., J. Winthrop Peabody, Sr., M.D., Leo G. Rigler, M.D., Israel Steinberg, M.D., Harold G. Trimble, M.D. Sponsored by the American Col-

lege of Chest Physicians. A volume of 484 pages, with numerous roentgenograms. Published by Charles C Thomas, Springfield, Ill., 1958. Price $19.50.

TUBERCULOSIS IN WHITE AND NEGRO CHILDREN. VOLUME I: THE ROENTGENOLOGIC ASPECTS OF THE HARRIET LANE STUDY. By JANET B. HARDY, M.D.C.M. A volume of 122 pages, with 227 roentgenograms, 12 photographs, and 21 line drawings. Published for the Commonwealth Fund by Harvard University Press, Cambridge, Mass., 1958. Price $7.50.

TUBERCULOSIS IN WHITE AND NEGRO CHILDREN. VOLUME II: THE EPIDEMIOLOGIC ASPECTS OF THE HARRIET LANE STUDY. By MIRIAM E. BRAILEY, M.D., Dr.P.H. A volume of 103 pages, with 8 graphs and 39 tables. Published for the Commonwealth Fund by Harvard University Press, Cambridge, Mass., 1958. Price $4.50.

RADIOLOGICAL PHYSICS. By M. E. J. YOUNG, M.Sc., formerly Lecturer in Physics, Royal Free Hospital School of Medicine (University of London). A volume of 366 pages, with 184 figures. Published by Academic Press, Inc., New York 3, N. Y., 1957. Price $7.50.

TELEVISION IN SCIENCE AND INDUSTRY. By V. K. ZWORYKIN, E.E., Ph.D., D.Sc. (hon.), Honorary Vice-President and Technical Consultant, Radio Corporation of America, Affiliate, Rockefeller Institute for Medical Research, E. G. RAMBERG, Ph.D., Research Physicist, RCA Laboratories, Princeton, N. J., and L. E. FLORY, B.S. (E.E.), Research Engineer, RCA Laboratories, Princeton, N. J. A volume of 300 pages, with numerous figures. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1958. Price $10.00.

INTERNATIONAL CLASSIFICATION OF DISEASES. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death Based on the Recommendations of the Seventh Revision Conference, 1955, and Adopted by the Ninth World Assembly Under the WHO Nomenclature Regulations. Volume I. New edition. A volume of 394 pages. Published by the World Health Organization, Palais des Nations, Geneva, Switzerland, 1957. Distributed in the United States by Columbia University Press, New York 27, N. Y. Price $6.75 for 2-volume set.

ANNUAL REPORT 1956–1957, THE ONTARIO CANCER TREATMENT AND RESEARCH FOUNDATION AFFILIATED WITH THE BRITISH EMPIRE CANCER CAMPAIGN. A paper-bound monograph of 137 pages, with 20 figures and 15 tables. Published by the Foundation, 69 Bloor St. E., Toronto 5, Canada.

INFLUENCE DES RAYONS X ET DES RADIATIONS ATOMIQUES SUR LE PATRIMOINE HÉRÉDITAIRE HUMAIN. By Docteur Marie-Odile Rethoré. Preface by Professeur R. Turpin. A monograph of 68 pages, with numerous tables. Published by G. Doin & Cie, 8, Place de l'Odéon, Paris, 6e, France, 1957. Price, paper bound, 500 francs.

LA ROENTGENTHÉRAPIE DES AFFECTIONS RHUMATISMALES. By PIERRE PIZON. A volume of 276 pages, with 60 figures and 39 tables. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris, 6e, France, 1957. Price, paper bound, 2,800 francs.

DER LUNGENBOECK IM RÖNTGENBILD. By Prof. Dr. KARL WURM, Chefarzt privater Kuranstalten in Höchenschwand i. Schw., a. o. Professor für inn. Med. der Universität Freiburg/Brsg., Prof. Dr. H. REINDELL, Oberarzt der Med. Universitätsklinik, Leiter der Röntgen-Radium-Abteilung Freiburg/Brsg., and Prof. Dr. Dr. h. c. L. HEILMEYER, Direktor der Med. Universitätsklinik Freiburg/Brsg. A volume of 220 pages, with 209 roentgenograms, 5 charts and diagrams, and 13 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 78.—($18.55).

Book Reviews

BASIC FOUNDATIONS OF ISOTOPE TECHNIQUE FOR TECHNICIANS. Edited by WILLARD C. SMULLEN, M.D., F.A.C.R., Radiologist in Charge, St. Mary's Hospital, Decatur, Ill. A volume of 164 pages, with 54 illustrations and 7 tables. Published by Charles C Thomas, Springfield, Ill., 1956. Price $4.75.

This volume is an excellent introduction to the basic fundamentals of nuclear medicine as practiced at the present time. The principles behind the use of the radioactive materials, the various means of measurement of dosage for each, and the routes of administration, are well presented in a manner suitable for anyone planning to work in this relatively new medical field. The major portion of the manual is devoted to the most widely accepted uses of isotopes, without going beyond the elementary requirements of physical or mathematical detail necessary to work in this field in any capacity.

Separate chapters serve to orient the technician in the radioisotope program, introduce him to the basic foundations of radioactivity, and provide him with an understanding of the essentials of self-protection. The rest of the text has to do for the most part with specific laboratory procedures in the use of radioiodine, phosphorus, and gold, from the standpoint of duties of the isotope technician. Short discussions

of less widely used procedures are also presented, without an attempt to include the more technical details. A list of the leading radiopharmaceuticals and their descriptions, as well as the training required for their procurement and use, is provided.

This manual is highly recommended as an aid to any one planning to assist an isotope therapist. It also serves as a good introductory text for the physician who is entering this field.

BASIC MECHANISMS IN RADIOBIOLOGY. IV. CELLULAR ASPECTS. Proceedings of an Informal Conference, Bear Mountain, New York, May 12–14, 1955. HARVEY M. PATT and E. L. POWERS, Editors. Nuclear Science Series Report Number 18, Subcommittee on Radiobiology, Committee on Nuclear Science. A volume of 190 pages, with 18 figures and 2 tables. Publication Number 450, National Academy of Sciences-National Research Council, Washington, D. C., 1956. Price, paper bound, $1.75.

In an effort to stimulate exchange of information among the older disciplines that make up the science of radiobiology, the Subcommittee on Radiobiology of the Committee on Nuclear Science has organized joint conferences among physicists, biochemists, and biologists to discuss phases of radiation effects where these fields have been brought together. This is the fourth of such conferences, the programs of which have been transcribed and published. The conferences are informal in character, and the book is a verbatim transcript of the discussions that were carried on.

Five sections correspond to the five sessions of the conference. A particular problem was introduced briefly at each session, with discussion among the various members proceeding immediately. The subjects covered included: Cellular Changes Following Irradiation, Problems of Cell Division Following Irradiation, Chromosome Aberrations Following Irradiation, Use of Radiation and Other Agents for a Study of the Mechanism of Mutation Production, and Relation of the Morphology of the Cell to Its Functional Behavior Following Irradiation.

This is a fascinating little volume, but it is primarily a discussion by experts for experts, and it presupposes a fair amount of knowledge regarding radiochemical and radiobiological problems which may limit its audience.

THE YEAR BOOK OF CANCER (1956–1957 YEAR BOOK SERIES). Compiled and edited by RANDOLPH LEE CLARK, JR., B.S., M.D., M.Sc. (Surgery), D.Sc. (Hon.), Houston, Texas, Director and Surgeon-in-Chief, The University of Texas M.D. Anderson Hospital and Tumor Institute; Professor of Surgery, The University of Texas Postgraduate School of Medicine; Clinical Professor of Surgery, Baylor University College of Medicine; Fellow, American College of Surgeons, and RUSSELL W. CUMLEY, B.A., M.A., Ph.D., Houston, Texas; Director of Publications, The University of Texas M.D. Anderson Hospital and Tumor Institute; Professor of Medical Journalism, The University of Texas Postgraduate School of Medicine. A volume of 572 pages, with 210 figures. Published by the Year Book Publishers, Inc., Chicago 11, Ill., 1957. Price $7.50.

The annual output of literature on the subject of cancer is voluminous, it being estimated that over 4,000 articles are published each year which have bearing on this subject. This new addition to the Year Book Series represents an attempt to select and review significant articles in this field.

The value of a book of this sort depends on how judicious the selection of articles for abstracting has been. Since no one person could have a sufficiently broad grasp of the field, the editors have endeavored to select a group of physicians and scientists who have attained a greater familiarity than average with various aspects of the subject. A total of 119 such persons has been chosen and divided into subgroups corresponding to the twenty-five sections under which the field of Oncology is considered. A total of 207 articles have been abstracted by their authors in an effort to preserve the integrity of their presentation.

The book is divided into twenty-five sections. The first 10 sections represent anatomical divisions of tumor involvement, such as the head and neck, lung, leukemia, and lymphomas, etc. The remaining 15 sections are concerned with treatment and investigation. There are sections on Cytology and Pathology, Radiotherapy, Basic Research, Psychologic Aspects of Cancer, and others. The abstracts presented are unusually complete and contain many tables and illustrations.

Altogether this is an interesting and profitable book for anyone dealing with the diagnosis or, especially, the treatment of cancer. More extensive critical comment by the editors would be desirable to help the reader evaluate the relative significance of the articles.

ANGIOGRAPHIE UND KLINIK: TECHNIK, INDIKATIONEN, KLINISCHE BEDEUTUNG SOWIE FEHLER UND GEFAHREN DER ARTERIOGRAPHIE UND PHLEBOGRAPHIE. By RAINER GOTTLOB, Facharzt für Chirurgie, I. Assistent an der chirurgischen Abteilung des Kaiser-Franz-Josef-Spitals, Vienna (Vorstand: Professor Dr. F. Mandl). Band XII, Wiener Beiträge zur Chirurgie, begründet von Professor Dr. Rudolf Demel, Vienna. A monograph of 116 pages, with 57 figures and 3 tables. Published by Wilhelm Maudrich, Spitalgasse 1b, Vienna IX, Austria, 1956. Price DM 19.—

This monograph, Vol. XII of *Vienna Contributions to Surgery*, founded by the late Professor Demel, is primarily concerned with the clinical and practical aspects of angiography.

After a brief survey dealing with the history and development of angiography, the work is divided, almost equally, into two parts: arteriography and phlebography (venography). The first part (arteriography) describes in detail the essential technical factors in abdominal, pelvic and peripheral arteriography; the indications, general and specific; the value of arteriography for the diagnosis, prognosis, and therapy of circulatory disturbances; and finally the mistakes and dangers likely to be encountered. For demonstration of the abdominal and pelvic arteries the following methods are considered: retropleural aortic puncture (Gottlob and Bayer), high lumbar (subdiaphragmatic) aortography (Dos Santos), low lumbar aortography, ascending arteriography (Saito and Kamikawa), and catheter methods. Demonstration of the peripheral arteries is by means of orthograde and retrograde injections of the femoral artery below the inguinal ligament, ascending arteriography by way of the popliteal artery (Barker), and aortography.

Among the errors and dangers of arteriography, special attention is given to damage to the vascular wall by the contrast medium and adverse effects on the kidney and spinal cord.

Among the phlebographic methods are mentioned, first, intravenous injections into veins of the foot, varicography, puncture of the femoral vein at the level of the inguinal ligament, ascending phlebography by means of the vena cava (caudal), and other intravenous procedures. Second, a chapter is devoted to transosseous phlebography, with a discussion of injection of the radiopaque medium into the spongiosa of the calcaneus, tibial tuberosity, and the major trochanter (cavography).

As in the arteriographic section, the technical errors of the different methods, the possible hazards referable to the radiographic medium, the most frequent diagnostic mistakes, as well as the best means to avoid these pitfalls, are discussed in detail.

Although writen by a surgeon principally from a surgical point of view, for surgical purposes, this monograph does not neglect the radiological aspects and contains much of value to the practicing radiologist, presented in a concise and easily readable style. It can be recommended to anyone familiar with the German language.

The illustrations are clear and informative, and the bibliography is up to date, doing full justice not only to the European but also to the American literature.

IL PNEUMORETROPERITONEO NELLA DIAGNOSTICA DELLA PATOLOGIA SOTTODIAFRAMMATICA, CON PARTICOLARE RIGUARDO PER LO STUDIO DEI TUMORI. By L. ROSSI and A. BARONCHELLI. A monograph of 220 pages, with 211 illustrations. Published by Cappelli, Bologna, Italy, 1956. Price 4,000 lire.

This monograph is based on the interpretation of roentgenograms taken in over 600 patients in whom retropneumoperitoneum had been induced by the presacral route (first described by Ruiz Rivas). The procedure is relatively innocuous, the authors having observed only two severe reactions, neither of which had a fatal outcome. At the time of publication, only two fatalities had ever been reported in the literature. There are, nevertheless, a few contraindications, such as heart failure, aortic aneurysm, severe Addison's disease, and extreme cachexia. The procedure is indicated chiefly for the study of subdiaphragmatic tumors, and particularly their possible relationships with the kidneys and suprarenals, but allows, also, inspection of the outlines of the liver, spleen (including its contractility), pancreas, uterus, and adnexa. Comparison with barium studies of the gastrointestinal tract, excretory and/or retrograde urograms, with the help of body-section roentgenography, will often go a long way toward the preoperative determination of the exact state of affairs. Being well illustrated and adequately documented, this text is recommended to all those interested in the procedure.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Skull at Birth. Rohan Williams. J. Fac. Radiologists **8:** 290–311, July 1957. (Queen Charlotte's Hospital, London, England)

The author discusses the normal anatomy, congenital dysplasias, and traumatic lesions of the antenatal and neonatal skull, drawing upon sixteen years experience in a large hospital. Since the newborn skull will range in maturity from thirty to forty-five weeks following fertilization, there are wide limits of normal in skull size and degree of ossification. The variations are most striking in the parietal bones. The most reliable data on growth of the fetal and newborn skull are those of Scammon and Calkins (Growth in the Fetal Period. Minneapolis, Minn., University of Minnesota Press, 1929). One is seldom justified in being dogmatic about the degree of prematurity from the appearance of the skull, and on occasion a normal mature infant will show so little parietal ossification that a diagnosis of craniotabes may be entertained. About 60 per cent of neonatal skulls have parasagittal vascular grooves; vascular markings are otherwise lacking.

Minor developmental variations sometimes resemble disease or more severe dysplasias. Ossification of separate islets in the sutures is common and may be mistaken for an early sign of cretinism or osteogenesis imperfecta. Hereditary parietal foramina begin as a single posterior parietal opening; a median bridge ossifies and divides the defect into two foramina with bevelled margins.

Contrary to popular belief, the postmature skull can undergo slight moulding during labor. The author gives a detailed account of the mechanism of moulding in a vertex descent.

In cases of possible fracture, a thorough knowledge of the normal lines of incomplete fusion is essential and Scammon's diagram in Caffey's *Pediatric X-ray Diagnosis* is recommended. In cephalhematomata blood extravasates between the pericranial membrane and the outer surface of the vault bones; the involvement is limited to the margins of the bone, a useful point in differentiation from *caput succadaneum* or meningocele. Peripheral calcification often appears in twelve to fifteen days, and this gradually thickens and approximates the surface of the calvarium, where demonstrable thickening may persist for months or years. On occasion, localized osteoporosis or actual bone resorption may be a sequel to a cephalhematoma. Two or three tangential views may be necessary to localize the process, since a subcalvarial hematoma can produce similar changes. Tangential views will also show a loss of bony continuity in the majority of depressed fractures. The "classical" fracture of the occiput from excessive traction on the trunk during breech delivery is rare in modern practice.

Major anomalies can often be recognized on antenatal films. In *anencephalus* only part of the occipital bone is seen; the remaining bones of the vault are absent, and the cerebral hemispheres are rudimentary or nonexistent. *Microcrania* is nearly always due to underdevelopment of the brain, *i.e.*, micrencephaly. Various midline defects are seen in association with meningocele or meningo-encephalocele. Most of these are in the posterior vault, and some may involve the foramen magnum. *Iniencephalus*, a combination of crania bifida and high spina bifida, can be recognized antenatally by the marked hyperextension of the head, with the fetus always seen as a brow presentation. It is not appreciated that some cases of *macrocrania* are due to true enlargement of the brain, macrencephaly, without ventricular dilatation. The infants are retarded and have seizures, and the differentiation from hydrocephalus must be made by air studies. *Cyclopia* presents as a single orbital fossa, with great variation in ocular development. The small brain is fused, with a central ventricle, and the nose is either absent or a rudimentary organ above the orbit. In *cebocephalus* there are separate small orbital cavities, and the abnormal nose is usually below the eyes. Lesser variations of the bony orbit are common, but most are associated with corresponding variations in development of the eye.

Craniolacunia is usually associated with spina bifida. The curvilinear bony ridges lie along the inner table, and the skull is smooth on palpation. In craniofenestria, there is complete absence of bone between these ridges; and the bulging pericranial membrane gives a cobblestone feel to the head. These ridges and deficient zones bear no relationship to the cerebral sulci and gyri.

Deformities which result from premature closure of various sutures are briefly described.

A case of a large pharyngeal teratoma suspected on antenatal radiographs because of an irregularly calcified mass in the facial region is presented.

Sixty-five roentgenograms.

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The Radiological Evidence of Raised Intracranial Pressure in Children. George du Boulay. Brit. J. Radiol. **30:** 375–377, July 1957. (St. Bartholomew's Hospital, London, E. C. 1, England)

The author has studied the relationship between length of history of raised intracranial pressure and the presence of suture diastasis and changes in the sella turcica in children. His investigation was based upon 122 cases in which papilledema with headache and/or vomiting was regarded as indicative of raised intracranial pressure.

About three-quarters of the children with a history of high intracranial pressure for longer than six weeks exhibited changes in the skull on x-ray examination. Suture diastasis may develop very rapidly in young children, but after the age of ten it is usually evidence of a long-standing condition.

At least six weeks of high pressure usually precedes any sign of alteration in the sella turcica. Suture diastasis and osteoporosis are often seen together in childhood. Erosion of the sella turcica, when seen in young children without suture diastasis, is usually an indication of a tumor in the region of the sella.

Four tables.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

The Significance of Thinning of the Parietal Bones. Howard L. Steinbach and William G. Obata. Am. J. Roentgenol. **78:** 39–45, July 1957. (H. L. S., University of California Medical Center, San Francisco 22, Calif.)

The authors report 3 cases of thinning of the parietal

bones; the first in an eighty-five-year-old female, the other two in young men with clinical diagnoses of gonadal insufficiency. Roentgenograms of the first patient, obtained over a number of years, showed that the lesion was progressive. In 1937 there was only slight thinning of the parietal bones; by 1953 the thinning extended from about 2 cm. on either side of the midline down to the region of the superior temporal line. Diploic spaces disappeared, with only the inner table left intact in the area of maximum thinning. Generalized osteoporosis was also a feature. Apparently the condition in this case was acquired, and not, as commonly believed, a congenital abnormality.

The authors consider the possibility of a relationship between osteoporosis and parietal bone thinning. They point out that the area of parietal bone involved is the only part of the calvarium that is not the site of muscular attachment and not subject to muscular tension. It thus seems possible to explain the localized thinning on the basis of decreased osteoblastic activity as a result of gonadal insufficiency, senility, or other causes of osteoporosis in a region where there is little stress or strain. Since, however, the incidence of parietal thinning is low compared to that of osteoporosis, other etiologies are undoubtedly involved.

Nine roentgenograms; 2 drawings.

DAVID D. ROSENFELD, M.D.
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Radiological Study of Intracranial Calcifications. J. Legré and A. Massad. J. de radiol. **38:** 645–662, July-August 1957. (In French) (Marseilles, France)

The authors found 388 intracranial calcifications in 1,000 roentgen examinations of the skull when older equipment was used and 426 in 1,000 examinations made with modern equipment. Of these 814 calcifications, 655 are termed physiologic and 159 pathologic, of which 33 were verified anatomically.

Calcification of the pineal gland accounts for 40 per cent of the physiologic calcifications and calcifications of the choroid plexuses for 15 to 20 per cent. Calcification of the internal carotid artery in the neighborhood of the sella turcica occurs most frequently after the age of sixty years. Calcification of the falx accounts for 6 to 10 per cent. The remainder are principally calcifications of the petroclinoid ligaments and of the tentorium.

Pathologic calcifications are divided into two large groups: those in the parasellar region and those in the hemispheres. The most frequent (75 to 80 per cent) pathologic calcification in the sellar region is in craniopharyngioma, the calcification being cystic, nodular, or mixed. Occasionally chromophobe adenoma of the pituitary may show calcification.

Infraclinoid aneurysms of the internal carotid artery calcify, but never the supraclinoid variety. Hemangiomas or hamartomas may calcify in the suprasellar region, and are often mistaken for craniopharyngiomas.

Calcification in tuberculous meningitis is more common since the advent of antibiotic therapy. The authors have seen 2 patients with calcification around the chiasm or the basal cisterns in the suprasellar region.

Hemispheric calcifications may be solitary or multiple. Solitary calcification is seen both in tumors and nontumoral conditions. About 10 per cent of gliomas show calcification. The approximate incidence in the various types and the general appearance of the deposits are as follows:

Oligodendrogliomas, 80 per cent; filamentous or granular.

Astrocytomas, 20 per cent; deposits in the cyst wall.

Ependymomas (chiefly in children), 40 per cent; flocculent or nodular.

Glioblastomas, 7 per cent; usually filamentous.

Of meningiomas, 18 per cent exhibit calcification, spherical or granular in form, resembling a stone inside the brain. Rarely, one may see calcification in a pinealoma, lipoma of the corpus callosum, cholesteatomas (epidermoid) or teratoma.

Solitary nontumoral calcification occurs in subdural and intracerebral hematomas, arteriovenous malformations, tuberculomas, and abscesses.

Multiple calcifications are to be found in tuberous sclerosis; in neuroangiomatosis of the Sturge-Weber-Krabbe type (90 per cent of the cases), as linear, curvilinear or convolutional streaks; in neurofibromatosis (rare); in calcifying cerebral endarteritis of Geylin and Penfield; and in Fahr's disease, which is characterized by epilepsy, psychic disturbances, and athetoid movements. Calcifications are present in 90 per cent of patients with toxoplasmosis, very rarely in hydatid cysts, and in 15 per cent of patients with cysticercosis. Rarely, one sees calcification in trichinosis, torulosis, and coccidioidomycosis.

Forty-two roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

A Radiologic Study of the Brain Circulation by Rapid Serial Angiography of the Carotid Artery. Torgny Greitz. Acta radiol. (supp. 140) pp. 1–123, 1956. (Serafimerlasarettet, Stockholm, Sweden)

The recent experience with carotid arteriography at the Serafimerlasarettet in Stockholm is the basis for this monograph on circulation within the brain. The study covers examinations made since September 1954, when the technic of rapid serial angiography became standardized. The author considers that 20 exposures should be made in the lateral projection, at a frequency of up to six per second and never less than one per second. Frontal views consisting of three exposures with a manual changer were made at the time of a separate carotid injection.

Four milliliters of Triurol (Urokon) 50 per cent were injected manually *via* a needle inserted percutaneously into the artery. The injection syringe was equipped with microswitches which recorded on a continuous electrocardiographic strip the commencement and the termination of the injections. In most cases two exposures per second were made for the first five seconds, followed by one per second for the next ten seconds.

Circulation times were measured after injection of solutions labeled with I^{131}. Scintillation counters were used to record the flow of the radioactive material at two separate locations over the parietal veins draining into the superior longitudinal sinus and over the jugular vein.

Measurements of the intra-arterial pressures at the time of injection were made through needles inserted separately from the injecting needle in the carotid arteries. No measurable increase in carotid pressure was found in 6 patients injected with the standard 4-ml. dose of Triurol or in 3 patients injected with 4 ml. of physiologic NaCl. In the systemic circulation, however, the results were variable. In 10 patients the most frequent reaction was a sudden decrease in the

heart rate, with a simultaneous fall in blood pressure. Electrocardiographic tracings without intra-arterial pressure recordings were made during 100 injections of Triurol in 57 patients. Fifteen injections in a total of 11 patients produced extrasystoles, asystoles, and other abnormalities of rhythm attributable to vagus effect. In 30 patients the circulation time was measured by I^{131} administered in physiologic saline and then in Triurol. The contrast medium appeared to cause a tendency to a prolonged circulation time.

The sequence of filling of arteries and veins of the brain was measured on the lateral arteriograms of 30 patients, and found to be a matter of consistent progression, dependent mainly on distance from the carotid siphon. Measurement of the period between maximum concentration in the carotid siphon and in the parietal veins affords a representative mean circulation time for the hemisphere. The measurements thus obtained by angiography were found to have a significant correlation with circulation times measured with I^{131}. The circulation time in 32 "normal" arteriograms varied between 2.7 and 5.5 seconds. In 19 of these cases it ranged between 3.5 and 4.5 seconds. The author warns that no conclusions concerning the reason for prolongation of the circulation time should be drawn in individual cases unless an electrocardiogram is recorded simultaneously with the arteriogram, because in a few instances the contrast medium has a profoundly depressing effect on the circulation.

Circulation times were considerably longer in patients with cerebral tumors without choked disks than in normal material, and longer in tumor cases with choked disks than in those without. In 3 patients with occlusions of the internal carotid artery, peripheral collateral vessels were demonstrated. It appears, therefore, that the arteries of the brain are not end arteries and that Dandy was wrong in stating that "there is no possible collateral restoration of the function supplied by the middle cerebral artery after its closure." It was found, however, that the circulation is slower than normal in the involved areas.

In 12 patients with arteriovenous malformations, shunts of varying degree were observed, depending upon length and width of arteriovenous connections.

Seventy-one tumors were found in the material examined by carotid angiography. These included 20 meningiomas and 39 gliomas of various types. No statistically significant difference was found between gliomas and meningiomas in respect to circulation time, except that, of 7 patients whose intracerebral circulation times were longer than seven seconds, all had malignant gliomas.

Variations in the pattern of the circulation were helpful in differentiation of some tumors. Among the 20 meningiomas, for example, 7 showed "capillary blushes," which in all instances were of long duration. Blushes were found otherwise in only 1 astrocytoma and 1 metastatic tumor, and in both these instances were brief.

A value for the circulation rate through a tumor may be obtained by measuring the transit time from arterial to venous tumor vessels. The present study seems to indicate, however, that examination of the drainage veins is more often of value in this respect. Nine of the meningiomas showed identifiable drainage veins, of which some were dilated but others were of normal size. In 3 cases, in fact, a nondilated drainage vein was the only indication of abnormal circulation through the tumor. In all 9 the circulation time from the carotid siphon to the drainage vein was longer than to the normal part of the brain as determined at the parietal area.

Among 26 malignant gliomas, abnormal "tumor vessels" could be distinguished in 14, and drainage veins in 18. Ten of the cases with identifiable drainage veins showed no dilatation, but in 17 malignant gliomas circulation time to the drainage vein was shorter than to the parietal area, and in the 1 other case the circulation times were equal. This measurement of circulation times, therefore, afforded a clear-cut separation of malignant gliomas from meningiomas. Areas of poor vascularity were thought to be due usually to venous compression due to edema.

The author believes that when tumor veins or drainage veins are identifiable, they provide better correlation with the degree of malignancy than with the cellular characteristics of the tumor. Tumor vessels were found in only 2 of the 12 gliomas of Grades 1 and 2, but in 14 of the 25 gliomas of Grade 3. Drainage veins were encountered in 2 gliomas of Grades 1 and 2, but in 16 of Grade 3.

Numerous figures, including 80 roentgenograms.

ARTHUR S. TUCKER, M.D.
Western Reserve University

The Effect of Carotid Arteriography, Using 35 Per Cent Diodrast, on the Protein Content of the Spinal Fluid. George T. Tindall. J. Neurosurg. **14**: 430–433, July 1957. (Duke University School of Medicine and Duke Hospital, Durham, N. C.)

In those cases in which a diagnostic lumbar puncture is deferred until after cerebral arteriography has been performed, the effect of the latter procedure upon the protein content of the cerebrospinal fluid would seem to be of importance. With this in mind, the author did a lumbar puncture one to twelve hours before and twenty-four hours after arteriography in a series of 36 patients in whom 35 per cent Diodrast was used in amounts ranging from 20 to 100 c.c. The various diagnoses included in this group are summarized in a table. All arteriograms were obtained by percutaneous puncture of the carotid artery. For a control, two lumbar punctures were done twenty-four hours apart on each of 14 patients in whom carotid arteriography was not performed. An increase or decrease of 10 mg. per cent or more of the protein content was considered to be significant.

Of the 36 patients in the experimental group, 27 showed no change in the protein content of the cerebrospinal fluid twenty-four hours after arteriography; 8 showed a 10 to 20 mg. per cent decrease, and only 1 patient, a thirty-three-year-old man with an intracerebral hematoma, showed an increase greater than 10 mg. per cent. With this one exception, the changes in protein content of the cerebrospinal fluid in the control group were similar to those following arteriography. In neither group were there any consistent changes in the cellular pattern of the spinal fluid.

A possible explanation of the decrease of the protein content twenty-four hours following the first lumbar puncture is that the leakage of the cerebrospinal fluid at the site of the dural puncture could allow the ventricular and cisternal fluids to mix more than normally with the lumbar subarachnoid fluid. Since the ventricular and cisternal fluids each have a protein content less than that found in the lumbar subarachnoid space.

this would result in a lower value twenty-four hours later.

Three tables. DAVID FOXMAN, M.D.
Cleveland City Hospital

Laminagraphy with Cerebral Pneumography. R. A. Manfredi and F. Kruse, Jr. J. Neurosurg. **14:** 374–381, July 1957. (R. A. M., 912 S. Wood St., Chicago 12, Ill.)

Laminagraphic studies with pneumography have appeared sporadically in the literature (see, for example, Poppel *et al.*: Radiology **60:** 236, 1953). These reports have emphasized the value of midline laminagrams at the time of pneumography for evaluation of the third ventricle, the aqueduct of Sylvius, and the fourth ventricle, when problems of interpretation of the routine pneumograms arise. The authors have found laminagraphy equally valuable for demonstration of deformities and displacements of various regions of the lateral ventricles not visualized by routine and stereoscopic views. Routinely used, this procedure can make an unsuccessful pneumogram satisfactory, inasmuch as even small quantities of air in any region of the ventricles can be identified with accuracy. The exposure factors and positional technics are presented.

Two cases of intracranial mass lesions are reported. In one of these combined pneumography and laminagraphy afforded excellent localization of the tumor, making unnecessary such additional procedures as arteriography. In the second case, the combined procedure showed the mass lesion in the occipitotemporal region, whereas on routine studies it would have been suspected to lie in the frontal region.

Eight roentgenograms. DAVID FOXMAN, M.D.
Cleveland City Hospital

Tantalum Powder as an Indicator of Brain Tumour Region for Postoperative Radiotherapy and the Diagnosis of Recurrence. M. Lindgren, F. O. Löfgren and N. Lundberg. Acta radiol. **48:** 17–25, July 1957. (University Hospital, Lund, Sweden)

The authors describe their use of a tantalum powder paste generously applied at operation to the surfaces from which cerebral gliomas are resected to facilitate their location on roentgenograms postoperatively. The opacities serve as a guide in radiotherapy and evidence of displacement enhances early detection of recurrence.

The method was used as a guide for postoperative radiotherapy in 25 cases. Thirteen patients were periodically examined roentgenographically to demonstrate possible recurrences. In 10 of these migration of the tantalum powder suggested recurrence and this was verified in 3 cases by encephalography and operation and in the remainder by the future course of the disease. It is suggested that control films be made postoperatively and again in two months, by which time postoperative changes should be complete.

Three complete case reports are included.

Sixteen roentgenograms. E. LITTLE, M.D.
University of Arkansas Medical Center

Bilateral Symmetrical Aneurysms of Internal Carotid Artery within the Cavernous Sinus; Case Report. Jacob Seltzer and Everett F. Hurteau. J. Neurosurg. **14:** 448–451, July 1957. (J. S., 6952 Sherwood Road, Philadelphia 31, Penna.)

To the authors' knowledge only 10 cases of bilateral aneurysms of the internal carotid artery within the cavernous sinuses, of nontraumatic origin, have been reported in the literature. In only 2 of these was the diagnosis made antemortem.

The authors present an additional case for its interest and statistical value. A forty-seven-year-old white female showed signs referable to involvement of structures within the left cavernous sinus. Routine roentgenograms of the skull were negative. Right and left carotid arteriograms showed large symmetrical aneurysms of the internal carotid arteries within the cavernous sinuses.

The aneurysm on the left (which caused the symptoms) was treated by occlusion both proximal and distal to the aneurysm, following which a good therapeutic result was obtained. The authors state that they are perplexed about the therapy of the aneurysm on the right, should it become symptomatic, and would be most grateful for pertinent suggestions.

Four roentgenograms. DAVID FOXMAN, M.D.
Cleveland City Hospital

Glomus Jugulare Tumours of the Temporal Bone. R. A. Kemp Harper. J. Fac. Radiologists **8:** 325–334, July 1957. (Diagnostic Radiology Department, St. Bartholomew's Hospital, London, E. C. 1, England)

This paper deals with the radiological diagnostic aspects of glomus jugulare tumors. The changes vary with the origin and extent of the tumor. If it arises in the temporal bone, sclerosis of the mastoid and petrous regions is sometimes the first sign. The dense bone may represent infection directly related to the tumor or it may be coincidental in a patient with past infection; tomography will often reveal an irregular area of erosion. At a later stage there is destruction of the middle ear and labyrinth, and large defects appear in the petrous bone. The tegmen may be elevated, but it usually remains intact until very late in the disease.

When the lesion arises in the jugular bulb the jugular foramen enlarges early. Later there is extension into the carotid canal and apex of the petrous pyramid. The tumor can spread medially to erode the articular process of the occipital bone and anteriorly to involve the temporomandibular joint. As a reflection of the increased vascularity the groove of the mastoid emissary vein may enlarge and the vertebral artery foramen in the atlas will often be larger on the affected side. This can be confirmed by cerebral or vertebral angiography, which will show marked vascularity in the mastoid area and large external carotid and vertebral arteries. In the late stages, enlargement of the pituitary fossa and erosion of the dorsum sellae will occasionally occur, due either to direct spread into the sphenoid bone or increased pressure from obstruction of the aqueduct.

In addition to the usual mastoid views, an axial view *i.e.*, 20° short of a full submentovertical position, will be useful, since the jugular foramen is projected just below the inferior margin of the mandible. Tomography in the anteroposterior position is very helpful; if doubt still exists, angiography of the external carotid and vertebral arteries can be valuable.

A number of conditions are to be considered in the differential diagnosis. Carcinoma of the middle ear tends to spread laterally, with little or no involvement of the inferior surface and apex of the petrous bone. Similarly, a cholesteatoma does not extend as far medially or inferiorly as a glomus tumor. A nasopharyngeal

tumor can invade the base of the skull and inferior aspect of the petrous bone, but the involvement is bilateral; the presence of a nasopharyngeal mass should resolve the difficulty if one suspects a rare case of bilateral glomus tumors. In acoustic neuroma the destruction is usually well defined, with no inferior extension.

Thirty-one roentgenograms.

LAWRENCE A. POST, M.D.
University of California, S. F.

Brachial Vertebral Angiography in Adults. William F. Collins, Jr., Harry W. Slade, and William G. Lockhart. J. Neurosurg. **14:** 466–468, July 1957. (H. W. S., 2224 Washington Ave., Waco, Texas)

Gould, *et al.* (J. Neurosurg. **12:** 369, 1955. Abst. in Radiology **66:** 775, 1956) described a method of filling the vertebral-basilar system by retrograde brachial arterial injection of contrast material. They recommended the procedure for children in whom it is desired to investigate the vertebral or right internal carotid circulation, but not for adults except when attempts at vertebral angiography by the usual means fail.

The present authors have modified the method of Gould, *et al.* by using a No. 12-gauge arterial cannula and a syringe with a No. 12-gauge opening and by this means obtained diagnostic vertebral angiograms in 16 of 17 adults. Two representative cases are presented: an aneurysm of the basilar artery and a large arteriovenous malformation of the right cerebellar hemisphere.

Four roentgenograms.

DAVID FOXMAN, M.D.
Cleveland City Hospital

Myelographic Demonstration of Brachial Plexus Root Avulsion. R. A. Mendelsohn, I. H. Weiner, and J. M. Keegan. Arch. Surg. **75:** 102–107, July 1957. (I. H. W., Department of Neurosurgery, University Hospital, Baltimore, Md.)

Stretch injuries of the brachial plexus may occur when the head and shoulder are forcefully separated or when the arm is forcefully hyperabducted, resulting respectively in upper plexus injury of the Erb-Duchenne type and the lower Klumpke type. Combined or mixed types may also be seen. In some instances a presumptive diagnosis of root avulsion may be made from the neurologic findings but frequently the nature and extent of the lesion will not be clear-cut on the clinical findings alone.

Eleven consecutive cases of stretch injury of the brachial plexus were studied by cervical myelography. In each instance 9 c.c. of Pantopaque were injected by the lumbar route and the contrast material carried to the cervical region. Pooling is allowed in the latter area for at least ten minutes because of the established fact that important diagnostic findings may not appear immediately. Sometimes a gentle turning of the head so that the injured side is downward will favor demonstration of meningeal injuries.

Two patterns of myelographic changes characteristic of nerve root injury are described. The first and more spectacular is formation of rounded diverticula with contrast material migrating laterally into the region of the intervertebral foramen and soft tissues of the neck. Varying degrees of elongation of the axillary sheath fall in the same group. Less commonly filling defects may appear at the level of the axillary sheath, with replacement or deformity of the root pouches.

Seven of the 11 patients showed myelographic abnormalities interpreted as nerve root avulsion. In 4 of these a clinical diagnosis of nerve root avulsion could not be made accurately, and the myelogram contributed valuable information. If nerve root avulsion is demonstrable by myelography then exploration of the brachial plexus is not indicated. Early reconstructive surgery may be considered later.

Eight roentgenograms illustrate the points under discussion. Details of the cases are tabulated.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE CHEST

So-Called Pulmonary Adenomatosis. W. Schlungbaum. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 679–690, June 1957. (In German) (Spandauer Damm 130, Berlin-Charlottenburg 9, Germany)

There have thus far been recorded in the literature approximately 200 cases of a disease of the lungs which has been variously termed pulmonary adenomatosis, alveolar carcinoma, alveolar epithelial tumor, adenomatous pneumonia, mucocellular papillary adenocarcinoma, cystopapillary lung tumor, and carcinoma of the terminal bronchi. In some reports, the term *Jaagsiekte* has been used, though actually this is a lung ailment of sheep, probably due to a virus.

Pulmonary adenomatosis is an entity in its own right but not necessarily a disease *sui generis*. This double statement is necessary because there is a possibility that it is simply a peculiar form of widespread bronchiolar metastasis from a concealed or microscopic primary lesion. Clinical characteristics include severe cough, copious watery sputum, dyspnea, progressive sialosis, and an invariably fatal ending.

The disease comprises somewhat less than 1 per cent of all pulmonary neoplasms, with no recent increase in incidence such as is being shown by bronchogenic carcinoma. Because the hypothesis has been made that adenomatosis may be secondary to bronchogenic carcinoma, it should be noted that the cellular structure does not correspond to that disease, that the sex incidence inclines toward the female side, and that there is no association with smoking. The author's opinion is that there is no relationship to any of the current known forms of malignant disease with the possible exception of the female type of adenoma of the lung. Further hypotheses as to the histogenesis include a virus infection manifesting itself with neoplastic tendencies, a multicentric primary tumor, and multiple metastases from an extrapulmonary lesion.

On postmortem examination, metastases are found in 45 to 50 per cent of all cases, with hilar lymph nodes predominating. This is in contrast to a rate of 80 to 90 per cent in bronchogenic carcinoma and only 5 to 10 per cent in bronchial adenoma. Involvement is usually of both lungs, with lesions recognizable in all lobes. The roentgen findings themselves are not diagnostic, but taken along with the history are suggestive. Multiple flecks of infiltrate, widely distributed through both lungs, tend to localize in the lower portions. Pleurisy occurs in only 10 per cent of the cases. Hilar adenopathy is an unusual roentgen finding.

The author reports 5 cases which are characteristic of the ailment plus 2 questionable cases. The latter 2 displayed the proper roentgen and pathologic criteria, but a primary lesion was known to be present elsewhere

and the lung changes apparently were due to metastatic spread from this focus.

Eighteen roentgenograms; 1 photograph; 2 tables.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Bronchiectasis of the Apical Segment of the Lower Lobe. Ingemar Hessén. Acta radiol. **48:** 7–13, July 1957. (Sabbatsbergs Sjukhus, Stockholm, Sweden)

The author reviewed 100 cases of bronchiectasis in which bilateral bronchography had been performed. He found bronchiectasis limited to the apical segment of a lower lobe in 4 cases. In all 4 the disease was manifested by hemoptysis, and the bleeding resulted in ill-defined densities on the film, which tended to come and go. When first seen, these densities are difficult to differentiate from tuberculosis and peripheral carcinoma.

Forty-six per cent of the author's series had bilateral disease as contrasted with the 30 to 40 per cent previously reported in the literature. The middle lobe was involved alone in only 12 per cent of cases and the lingula in 7 per cent.

Eight roentgenograms; 1 table.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Tuberculosis in Hospital Employees as Affected by an Admission Chest X-Ray Screening Program. George Jacobson, Donald D. Hoyt, and Emil Bogen. Dis. of Chest **32:** 27–38, July 1957. (G. J., Department of Radiology, Los Angeles County Hospital, Los Angeles, Calif.)

The authors illustrate the effectiveness of a routine admission chest x-ray examination in reducing the incidence of tuberculosis in the personnel of a large general hospital. Tuberculosis is an occupational hazard to hospital employees; the incidence was six times as high in those having close contacts with patients—physicians, nurses, attendants, laboratory technicians—as among clerical and other nonexposed personnel.

Ninety employees of Los Angeles County Hospital were awarded compensation for tuberculosis during a fourteen-year period, from 1942 through 1955. Negative chest roentgenograms were available in two-thirds of this group before the disease was discovered. In the majority, the tuberculous lesions developed in less than two years after a negative chest film. The extent of the disease at the time of detection was either minimal or moderately advanced in 69. Five are known to have died from the disease.

In 1951, the hospital instituted a routine admission chest x-ray screening program, and subsequent figures show a drop in the incidence rate of employee tuberculosis, with no cases during the last three years (1953–55).

The routine admissions x-ray examination resulted in early recognition and isolation of unsuspected tuberculous patients, reduced exposure of ward personnel, and practically eliminated the danger of an employee contracting tuberculosis.

Two graphs; 9 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Limitations of Laminagraphic Interpretation in Pulmonary Tuberculosis. David E. Thomas. J. Thoracic Surg. **34:** 53–55, July 1957. (Valley Forge Army Hospital, Phoenixville, Penna.)

The author studied the limitations of laminagraphic interpretation in pulmonary tuberculosis. His conclusions are based upon a study of 5 patients who were selected for excisional surgery. The common denominator in each case was the interpretation of the laminagram. In this series the percentage of correct diagnoses was little better than one could obtain by chance alone. The author concludes that the differentiation of closed and open cavities by laminagrams is often not possible.

One table.

THEODORE E. KEATS, M.D.
University of Missouri

Incidence of Chronic Pulmonary Disease Among Patients with Esophageal Disorders. Joseph R. Vivas and Eddy D. Palmer. Dis. of Chest **31:** 568–574, May 1957. (J. R. V., Madigan Army Hospital, Tacoma, Wash.)

A study of 100 patients with esophageal disorders is presented in this paper. Twenty-two of these patients had chronic pulmonary disease. Included as esophageal disease were 43 cases of hiatus hernia, without secondary esophageal change. Two patients in this group had pulmonary disease. Chronic lesions of the lungs were also found in 4 of 13 patients with diverticulum of the esophagus; 2 of 12 patients with erosive esophagitis; 6 of 8 patients with achalasia; 3 of 7 patients with esophagitis and hiatal hernia. No pulmonary disease was encountered in 6 patients with stricture due to esophagitis, in 3 patients with congenital stricture, or in 1 patient with a radiation stricture. Two of 3 patients with carcinoma of the esophagus had pulmonary lesions as did both of 2 patients with lye stricture, and 1 of 3 with a Zenker's diverticulum.

The pulmonary diseases represented were chronic bronchitis, 8 cases; recurrent pneumonia, 9 cases; chronic pulmonary fibrosis, bronchiectasis, lung abscess, pneumothorax due to perforation, and empyema due to perforation in 1 case each. The mechanism of the pulmonary involvement seems to be one of periodic transadital aspiration of material from the esophagus, probably nocturnal.

Nine roentgenograms; 2 tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Massive Atelectasis of the Left Lung in Children with Congenital Heart Disease. Laurence M. Rivkin, Raymond C. Read, C. Walton Lillehei, and Richard L. Varco. J. Thoracic Surg. **34:** 116–125, July 1957. (University of Minnesota Medical School, Minneapolis, Minn.)

The authors discuss massive atelectasis of the left lung in children with congenital heart disease on the basis of their experience with 8 such cases. All of these patients had increased pulmonary blood flow and pulmonary hypertension. In 5 cases atelectasis was present prior to surgical correction of the cardiac defect. In 3, massive collapse of the left lung appeared for the first time during the postoperative period. This pulmonary problem has not occurred with the reduced pulmonary blood flow that exists in the tetralogy of Fallot.

At surgery, in each of the cases, the pulmonary artery was observed to be large, tense, and pulsatile. The authors ascribe the production of atelectasis of the left lung to compression of the left main bronchus by an enlarged left pulmonary artery. This observation has been made not only during operations but also postmortem. Furthermore, bronchoscopy has revealed

obstruction, extrinsic in origin and involving the left main-stem bronchus at the site where it is crossed by the left pulmonary artery.

Prevalence of this condition in infancy is probably related to the small lumen and soft nature of the bronchus. Similar severe pulmonary artery enlargement in older patients does not result in a corresponding state of bronchial obstruction.

The appearance of partial or total collapse of the left lung has been considered an indication for, rather than a contraindication to, definitive correction of the cardiac anomaly, since spontaneous resolution of the atelectasis has been observed only following a curative operation. The onset of radiologically visible obstructive emphysema in the left lung represents an urgent indication for surgery before massive collapse occurs.

Eleven roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Spontaneous Pathologic Fractures in an Infant with Chronic Thoracic Empyema. Marie Suntychová. Radiol. clin. **26:** 209–215, July 1957. (In German) (Na stráži 40, Prague 8, Czechoslovakia)

The author reports symmetrical spontaneous fractures of both humeri and the right femur in a baby with chronic empyema of the chest with interlobar localization. An effort is made to relate the empyema and fractures. Chronic suppuration must lead to increased need but diminished utilization of vitamins. Further, protein, fat, and mineral metabolism must be impaired, finally leading to pathologic changes in the skeleton. This complex conception of the total clinical picture receives some support from the improvement in the bone symptomatology following the improvement of the empyema with vitamin supplement.

While it is incontestable that the whole organism is affected by such a process as an empyema persisting for some four months, it cannot be definitely decided in what measure the process influenced the skeleton directly or indirectly through the disturbance in intestinal absorption, or fat, mineral and protein metabolism.

Vitamin supplement had such a striking therapeutic effect that vitamin lack must have played a decisive role.

Six roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Chordoma of the Thoracic Spine Appearing as a Mediastinal Tumor; Report of Two Cases. Janusz Buraczewski and Witold Rudowski. J. Thoracic Surg. **34:** 75–84, July 1957. (Institute of Oncology, Warsaw, Poland)

The authors report 2 cases of chordoma of the thoracic spine appearing as a mediastinal tumor. In each instance a posterior mediastinal mass with evidence of vertebral destruction was detected radiologically.

A thoracic localization of chordoma is quite exceptional, the sacrococcygeal region being the predominant site of involvement. The roentgen pictures in the 2 reported cases showed sufficient similarity to allow some conclusions concerning the radiologic differential diagnosis. Chordoma of the vertebrae, in the more advanced stages, appears as a tumor enveloping the body of the vertebra from at least three sides and may be visible on both sides of the spinal column and posteriorly when it causes destruction of the neural arches or enters the spinal canal. It results in destruction of vertebral bodies and their eventual collapse. Such a radiologic finding, when supported by clinical evidence of long-lasting symptoms with small static disturbances, especially when more than one vertebra is involved, should allow the tentative diagnosis of chordoma.

Chordoma should be considered as a possibility when a differential diagnosis of posterior mediastinal tumors is considered.

Eight roentgenograms; 5 photomicrographs; 3 drawings. THEODORE E. KEATS, M.D.
University of Missouri

Tracheal Diverticulosis. Leon Goldman and J. Gwynne Wilson. Arch. Otolaryng. **65:** 554–557, June 1957. (San Francisco Hospital, San Francisco 10, Calif.)

The authors review the literature on tracheal diverticulosis and report a case in a 43-year-old man, who was admitted to the hospital complaining of a "chicken bone caught in the throat." Roentgen examination revealed a radiopaque object measuring 2 mm. × 3 cm. parallel to and between the trachea and cervical spine at the level of C-6. Immediately below the foreign body on the lateral film was a radiolucent area measuring 2 × 1 cm. The trachea was widened in its midportion. On barium swallow, no esophageal diverticula were found. The esophagus, however, deviated in a smooth curve to the level of T-1 and T-2, apparently because of the tracheal widening. Tracheograms taken after removal of the piece of bone showed the above mentioned radiolucency, representing a diverticulum of the trachea with a relatively narrow inlet; in addition, the contrast medium outlined numerous other diverticula on the right posterior aspect of the trachea, varying in size from 3 mm. in diameter to the 2 × 1 cm. air-filled diverticulum seen on the plain films.

Five roentgenograms; 1 drawing.

A Technique of Bronchography with Visciodol: A New Contrast Medium. Ergi J. Pesiri and Waldron M. Sennott. Dis. of Chest **31:** 548–555, May 1957. (W. M. S., United States Public Health Service Hospital, Staten Island, N. Y.)

The authors list several disadvantages of iodized oil in bronchography, including passage of the oil into the alveoli, slow elimination from the lung preventing follow-up examination for long periods of time, and prolongation of reactions in iodine-sensitive individuals. The more recently introduced water-soluble agents, including Dionosil Aqueous, are also open to certain objections.

Visciodol has been found to overcome many of these difficulties. It is a Lipiodol-sulfanilamide suspension consisting of sulfanilamide 0.32 gm., sodium sulfite 0.002 gm., and Lipiodol, 40 per cent q.s. to 1 c.c. The sulfanilamide is added as an inert agent to increase the viscosity of the Lipiodol and prevent alveolar penetration. The sodium sulfite prevents liberation of free iodine on contact with air.

The authors report 35 studies made with this material. They were particularly impressed with the minute degree of alveolar penetration, the high density of the image produced, the lack of irritation, and the rapid elimination of the medium. In 1 patient a transient sulfonamide reaction was encountered.

Eight roentgenograms. DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Air Contrast Bronchography. Gerald L. Haidak, Bernerd Caplan, and Walter H. Maloney. J. Thoracic Surg. **34:** 63–66, July 1957. (G. L. H., 769 North St., Pittsfield, Mass.)

The authors introduce a modification of the bronchographic technic involving the injection of air through the tracheal catheter to produce a double contrast type of film, as in gastrointestinal radiography.

Following the instillation of water-soluble Dionosil through a tracheal catheter, 150 to 200 c.c. of air is injected quickly through the catheter after all of the segments are filled with contrast material. It appears that the physical properties of Dionosil in its warm, liquid state are such as to respond to the forcing of air through the catheter by adhering to the bronchial mucosa and producing contrast bronchograms. No untoward side effects are noted and the results are of outstanding quality.

Three roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Anatomic Landmarks as Section Levels in Chest Stratigraphy. J. H. Marchand, J. Porot, and J. Ribière. Stratigrafia **2:** 9–17, January-March 1957. (In French) (J. H. M., Hôpital Lariboisiere, Paris.

It is common practice in body-section roentgenography to identify the layers by distance from the table top, in centimeters. In the case of the chest, this means centimeters from the skin. Considering only the possibility that a patient can gain or lose weight between progress examinations, the 10-cm. layer may not be the same after three or six months. Obviously, thus, one cannot assure adequate reproducibility for comparison.

It has been suggested that numeration of the layers be replaced by reference to anatomical landmarks. This is perfectly feasible in the skull but, so far as the chest is concerned, not only may the musculo-adipose covering change, but even internal organs and bony structures can be distorted and displaced by disease and aging processes. No definite solution of this problem has as yet been found, but the authors propose a compromise. In lateral stratigraphy of the chest, they would start numeration in centimeters to the left and to the right of the plane of the spinous processes, though a significant degree of scoliosis could prevent the use of this landmark. For anteroposterior stratigraphy of the chest, they take as a base line the posterior segment of the fourth rib, which is almost entirely in the frontal plane, and has less respiratory motion than the lower ribs. Satisfactory results demand painstaking attention to all the other details as well, from immobilization with respect to the table and exposure during the same respiratory phase to adequate electrical data and careful film processing. The proposed baselines do not provide the final answer, but their use seems to be a step in the right direction.

Nine figures.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

THE HEART AND BLOOD VESSELS

Cardiac Displacement in Pectus Excavatum. Alfred Vogl and Peter Elsbach. Ann. Int. Med. **47:** 145–152, July 1957. (A. V., 1165 Park Ave., New York 28, N. Y.)

Displacement of the heart is inevitable if the sternovertebral distance becomes shorter than the sagittal diameter of the heart. Such a reduction is rarely caused by deformation of the thorax through trauma or acquired disease of the bony parts but is almost always part of a constitutional anomaly, the main feature of which is depression of the sternum. There are two types of anomaly which have a reduction of the retrosternal space in common: the flat chest (platythorax) and the hollow chest (pectus excavatum). The flat chest represents that anatomic variety in which all the sagittal diameters of the thorax are uniformly (and usually only moderately) shorter than normal. The hollow chest occurs in one of two well defined forms. The more common form is the funnel chest, in which the shortening of the sagittal diameter is most pronounced at the level of the sternoxiphoid junction. Far less common is the grooved chest, in which the entire sternum is depressed and abnormally close to but equidistant from the spine. A case of grooved chest with pronounced displacement of the heart and esophagus in a twenty-four-year-old mentally retarded Negro girl is described in detail.

In the funnel-chest type of pectus excavatum, cardiac displacement is usually only slight. Complete shift of the heart into the left hemithorax, as seen in the reported case, is more likely to be encountered in the grooved chest type, in which the space between the sternum and the spine is at no level large enough to accommodate the heart. This severe narrowing appears to be caused not only by the depression of the sternum, but possibly, also, by forward displacement of the vertebral bodies. This observation tends to support the concept that pectus excavatum may result from an abnormal shortness of the strands of mediastinal connective tissue between sternum and spine.

Significant cardiopulmonary disturbances which have developed in patients with the chest deformities described are probably most often due to the impairment of pulmonary ventilation.

In the majority of cases of cardiac displacement due to sternal depression the prognosis is favorable and no cardiocirculatory complications are to be expected. These cases are of clinical interest chiefly because they may become a source of diagnostic and prognostic error by simulating serious structural organic heart disease.

Two roentgenograms; 2 photographs; 2 drawings.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Atrial Septal Defect in Children. Joan Wagner and Gerald R. Graham. Brit. Heart J. **19:** 318–326, July 1957. (J. W., Department of Medicine, University of Witwatersrand, Johannesburg, Union of South Africa)

The purpose of this paper was twofold: (1) to present the signs and symptoms of atrial septal defect and thus outline the findings that are of aid in making a clinical diagnosis; (2) to show the importance of early recognition. With this in view, 133 children with atrial septal defect were studied. In about 25 per cent the diagnosis was confirmed by cardiac catheterization; no mention is made of surgery.

Fluoroscopy is of importance, demonstrating enlargement of the right side of the heart, especially the outflow tract of the right ventricle, increased pulmonary vascularity, active pulsation of the pulmonary artery and dilatation of its main branches. The aorta is small. Films provide a permanent record of these findings and permit a leisurely study of the pulmonary vascular pattern. The degree of vascularity is a meas-

ure of the size of the shunt and the presence of pulmonary hypertension can often be determined by noting abrupt narrowing of the pulmonary arteries just beyond the hilus and tortuosity of these distal vessels.

Dyspnea, frequent respiratory infections, and poor nutrition were the common clinical features, but it was noted that there was no correlation between symptoms and objective evidence of cardiac disease as regards severity. On auscultation P2 was loud and split; a systolic murmur was heard, loudest in the left second or third interspace, and often there was soft apical diastolic murmur. The electrocardiogram showed right-sided hypertrophy, right bundle branch block, or both.

Four roentgenograms; 4 electrocardiograms; 3 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pericardial Cysts. (Two Case Reports with Special Reference to Bronchographic Examination and to Classification). G. Bracali and L. Perilli. Ann. radiol. diag. **30:** 138–172, 1957. (In Italian) (Istituto di radiologia e terapia fisica, Ospedale civile di Pescara, Pescara, Italy)

The typical appearance of a pericardial cyst on the chest roentgenogram is the well known sharply defined, triangular, homogeneous opacity in the right cardiophrenic angle. The names given to this entity are related to its anatomic location (pleuro-diaphragmatic cyst, pleuro-pericardial cyst, simple or thin-walled mediastinal cyst) or they may refer to its presumed origin (celomic cyst of the pericardium, pericardio-celomic cyst, mesothelial cyst of the mediastinum). In this paper another classification of pericardial cysts is added to the many offered in the literature. *True* cysts are dysembryogenic (mesodermo-celomic), inflammatory, or post-traumatic, while *false* cysts may be dysontogenic (mono-, di-, or tridermal teratomata), tumoral, or parasitic.

Two illustrative case histories are presented, the first, of a forty-eight-year-old female in whom a thoracotomy was performed. The second patient, a thirty-nine-year-old male, refused surgery because he was asymptomatic. Since the condition is benign, the decision for or against surgery is usually based on histologic examination.

Preoperative investigations recommended by the authors include chest fluoroscopy and roentgenography after pneumoperitoneum (said to be more efficient in ruling out diaphragmatic hernia than body-section roentgenography) and bronchography. Kymographic proof of transmitted pulsations in the triangular density is of little value. No mention is made of percutaneous puncture and aspiration of the cyst and subsequent instillation of contrast medium. With the predilection of Romanic authors for "needling," it seems unlikely that the authors would have omitted this procedure unless unaware of its potentialities.

Ten roentgenograms; 2 photomicrographs.

E.R.N. GRIGG, M.D.
Cook County Hospital, Chicago

The Pathogenesis and the Diagnostic Significance of the Costophrenic Septal Lines in Mitral Stenosis. D. Esch and P. Thurn. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 7–16, July 1957. (In German) (Medizinische Klinik der Universität, Bonn, Germany)

In patients with pulmonary congestion, particularly that due to mitral stenosis, fine horizontal sharply defined lines are occasionally seen in the costo-diaphragmatic angle and in the lower portion of the lungs. They measure from 0.5 to 3.0 cm. in length and are 1.0 to 2.0 mm. thick. They are parallel to one another and their number varies from two to fifteen. They were first described by Kerley and called "B-lines." Other names that appear in the literature are: "horizontal lines," "linear x-ray shadows" and "septal lines." They are easily differentiated from the plate-like atelectases, which are mostly solitary, heavier, and less distinctly outlined. The etiology of the septal lines is not clear, but they are thought to be due to edematous swelling of the interlobular septa.

The authors review 56 cases of mitral stenosis, of which 55 were treated surgically (valvulotomy). Careful studies of the arterial and also of the venous pulmonary pressure were made in every instance. The arterial pressure was measured with the cardiac catheter and the venous pressure was measured directly in the left auricle of the heart during operation. Septal lines were demonstrated in 31 of the cases (55.4 per cent). The average medial pulmonary arterial pressure was definitely increased, measuring 55 mm. Hg, but the increased pulmonary pressure alone does not produce the septal lines, since the authors had reviewed 100 cases of increased pulmonary pressure other than that due to mitral stenosis and in none were septal lines found.

A careful analysis shows that the percentage of septal lines increases if the arterial pulmonary pressure is increased, and particularly if the venous pulmonary pressure is increased. The highest percentage (91 per cent) was found with high arterial and venous pulmonary pressures.

After valvulotomy, in the majority of the patients the septal lines disappeared. They therefore represent a reversible process.

The authors conclude that the presence of septal lines in mitral stenosis usually suggests a rather severe condition and that the disappearance of the lines after valvulotomy indicates a good functional result. Failure of the septal lines to disappear does not, however, necessarily mean a poor result, since they may have become fibrotic or sclerotic, in which case they remain irreversible although excellent results have been obtained by surgery.

Seven roentgenograms; 1 graph; 2 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

The Question of Residual Systolic Blood in Man; Angiocardiographic Observations. A. Schaede and P. Thurn. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 696–710, June 1957. (In German) (Medizinische Universitätsklinik, Bonn, Germany)

The classical observations on the quantity of systolic residual blood in the human ventricle are given in the works of Frank in 1901, Straub in 1920, and Starling in 1926, on the basis of isolated mammalian heart preparations. The statement has been accepted that the residual blood is far less in volume than the cardiac output, with a relationship of the stroke volume to the residual volume of the order of 2:1, *i.e.*, 2 ounces to 1 ounce, in the man. Since the time of these earlier investigators, higher estimates of residual blood have been made by Reindell, Kjellberg and others. They favor a relatively large volume of residual blood in the ventricles, namely 2 to 3 ounces for every ounce of blood ejected from the heart.

Angiocardiography now provides a method superior even to kymography for studying the residual blood volume in the normal and in the diseased heart. Direct observation on an individual with a normal heart, recumbent and at rest, shows that in diastole the atria empty practically completely and that in systole the ventricles do likewise. The authors' films show that there is almost no residual systolic blood in either ventricle and that what traces can be detected are seen to lie immediately adjacent to the atrioventricular valves. Movement of these valves is found to be far beyond what one would ordinarily expect and it is obvious that a kymogram could not possibly indicate the degree of emptying of the heart. The studies show that increased cardiac efficiency cannot be obtained by means of the heart muscle working on the residual blood in the heart because this is normally so little. Increased cardiac output can be achieved only by increased cardiac inflow. In this respect it should be noted that in the Valsalva maneuver the decrease in the size of the heart is due not to decreased residual blood but to decreased engorgement of the atria, auricular appendages, and the great veins.

A heart burdened by an increased input, as from an arteriovenous fistula or a patent ductus arteriosus, shows an overall increase in size, but in the absence of decompensation there is no significant quantity of residual blood. The increase in size depends on the atria and not on the ventricles. The atria do not empty completely even when a significant atrial impulse can be detected. Once again a pronounced movement of the atrioventricular valves can be demonstrated. This latter finding would support the theory that a diastolic plateau on a kymogram is not a reliable sign of increased residual blood. In one of the instances studied by the author, a patient with a patent ductus arteriosus, the relationship of the stroke volume to the residual volume was of the order of 2 ounces to 1 ounce.

Obstruction of the cardiac outflow has a somewhat greater effect on residual blood. Studies were available on patients with pulmonic stenosis and with aortic stenosis. The greater increase in residual blood occurs in pulmonic stenosis, probably because of the chronicity of such a lesion in association with the inherently smaller size and lesser strength of the right ventricle. When the heart remains in good compensation, the increase in residual blood, particularly in the left ventricle, is significant, but good stroke volume is maintained. An observation here is that in many cases, the angiocardiograms indicate an enlargement of the left ventricle when the routine postero-anterior roentgenograms of the chest demonstrate a relatively normal-sized heart. This may be explained by the fact that much of the enlargement of the left ventricle is directed posteriorly and requires more than one view for adequate demonstration. Only when the heart is decompensated does the residual blood in the ventricles become marked. This allows ready differentiation of myocardial hypertrophy from cardiac dilatation.

Forty-one roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Cardioaortic Fistula: Temporary Circulatory Occlusion as an Aid in Diagnosis. Bernard L. Brofman and John C. Elder. Circulation **16**: 77–87, July 1957. (B. L. B., Mt. Sinai Hospital, Cleveland, Ohio)

The persistence of the authors of this single case report was finally rewarded by the demonstration of the actual fistulous tract resulting from rupture of a sinus of Valsalva aneurysm into the right ventricle. Numerous attempts failed, even though the clinical diagnosis was fairly certain. The combination which finally succeeded was injection of opaque medium directly into the base of the aorta by catheter during temporary circulatory occlusion. This was accomplished by manual compression of both carotids, the use of tourniquets on both arms, and inflation of a balloon-tip catheter placed in the inferior vena cava. The patient withstood the procedure well even when it had to be repeated because on the first attempt the aortic catheter went into the descending limb. The films showed the fistula well outlined with the medium. The presence of the tract was also proved by a spot film on which the catheter was seen entering the right ventricle through the ruptured aneurysm.

Open surgery was attempted, with the aid of a heart-lung machine. The rupture and a moderate sized ventricular septal defect adjacent were closed, but the heart failed and could not be made to beat again. The fistula was present fourteen months before operation. [It is unfortunate that the tremendous efforts—three previous sessions of catheterization and contrast injections—expended on this patient were not rewarded by surgical success, but the method devised may be a valuable diagnostic aid in other cases.—Z.F.E.]

Five roentgenograms; 2 photographs; 3 pressure tracings; 4 phonocardiograms; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Coarctation of the Aorta: Its Incidence and X-Ray Diagnosis. J. H. Hood. M. J. Australia **2**: 82–86, July 20, 1957. (Brisbane, Australia)

The author has written this article with the purpose of making generally known the roentgen features of coarctation of the aorta. He feels that this will aid in making the diagnosis and estimating the frequency of coarctation in routine chest surveys. While the detection of rib notching is difficult on 35-mm. films, the diagnosis may be made on the appearance of the mediastinal shadow. In a series of 26 cases seen in a five-year period, 7 were diagnosed on routine chest films. Coarctation may exist in all grades of severity, varying from slight narrowing to complete obstruction of the aortic lumen. With coarctation, the greater part of the blood volume is carried by the innominate, left common carotid, and left subclavian arteries, which become dilated, with consequent broadening of the superior mediastinum. The left subclavian artery, may also become tortuous and present a most characteristic appearance on the left side of the upper mediastinum. Below this, overlapping it in part, is the post-stenotic portion of the aorta. The double curve thus formed is almost diagnostic of coarctation. In about one-half the cases, however, neither of these two prominences was seen. The main pulmonary artery was therefore prominent, and in one case the anomaly was thought to be a pulmonary stenosis. In these cases it is the author's opinion that the subclavian and post-stenotic aorta were drawn into the mediastinal shadow because of traction on the aorta by the obliterated ductus.

By means of a barium swallow, one may see two impressions on the left side of the esophagus, neither being in the position of the normal aortic impression. The

upper is due to the dilated left subclavian and the lower to the post-stenotic portion of the aorta.

Cardiac enlargement was observed in 13 of the 26 cases, and the coarctation may be associated with other cardiac defects, especially in the presence of enlargement.

The collateral circulation may occur through (1) the vertebral arteries to the spinal arteries and thence to the spinal branches of the aortic intercostal arteries; (2) the thyrocervical trunk and thence *via* the suprascapular, transverse cervical or subscapular arteries to the scapular anastomosis and back into the thoracic aorta by way of the intercostal arteries; (3) the internal mammary arteries to the epigastric vessels and thence to the femoral arteries.

Blood from the scapular anastomosis may cause dilatation and tortuosity of the intercostals. This is the cause of the characteristic rib notching.

Four roentgenograms; 1 photograph; 12 drawings.

HOWARD GOULD, M.D.
St. Vincent's Hospital, N. Y.

Resection and Grafting for Chronic Occlusion of the Terminal Aorta or Iliac Arteries. John S. Welch, John W. Kirklin, F. Henry Ellis, Jr., and André J. Bruwer. J.A.M.A. **164:** 1045–1049, July 6, 1957. (J. S. W., 200 First St. S. W., Rochester, Minn.)

This paper presents the experience at the Mayo Clinic with 74 patients on whom resection and insertion of a graft were performed prior to June 15, 1956, for chronic occlusion of the aorta or iliac arteries. All patients complained of slowly progressing distress in the calf, thigh, hip, or back, induced by exercise and relieved at rest. This took the form of pain or a feeling of fatigue identical to claudication with accompanying absence or diminution of the arterial pulses of the lower extremities.

The diagnosis was made by translumbar aortography which the authors prefer to carry out with lumbar epidural block with lidocaine (Xylocaine) hydrochloride and epinephrine. Ten to 15 ml. of 70 per cent sodium acetrizoate (Urokon) are rapidly injected at the usual site. At the end of the injection an exposure gives a good outline of the abdominal aorta. When it is desired to demonstrate the iliac and femoral arteries to a point down to the knees, it is determined from the information thus obtained whether the aorta can be injected from a lower level. The first needle is then removed and a second reinserted well below the renal arteries. Here 40 to 50 ml. of the opaque medium (50 to 55 per cent) is slowly injected over a period of five to twenty seconds. At the end of the injection an exposure is made with 2 sheets of 14 × 17-in. film in the underlying 36-in. cassette. Occasionally it is necessary to compress the upper portion of the sound thigh when the danger of a rapid run-off due to unilateral obstruction is present. This procedure gives an adequate bird's-eye view of the iliac and femoral arteries without subjecting the renal arteries and/or the celiac axis to the hazards of the medium. Perfusion of vital organs with a potentially noxious agent is also avoided.

Whether the aortography revealed occlusion disease of the distal aorta or of the iliacs, surgical intervention with the implantation of homografts led to a better than 85 per cent improvement in signs and symptoms.

Eight roentgenograms; 2 photographs; 1 drawing.

SAUL SCHEFF, M.D.
Boston, Mass.

Simultaneous Occurrence of So-Called Right Deviation of the Descending Aorta in Uniovular Twins. H. Harders and M. Meier-Siem. Radiol. clin. **26:** 187–198, July 1957. (In German) (H. H., Martinistr. 52, Hamburg-Eppendorf, Germany)

As a result of atherosclerosis, the thoracic aorta uncoils and elongates, and, because of the fixity of the thorax, may take an abnormal course. Its lower segment may deviate toward the right and compress the esophagus. The esophageal compression may be increased by the shears-like action of aorta behind and the left atrium in front. The authors report this condition in uniovular sixty-eight-year-old male twins, as a text for a general discussion.

While arteriosclerosis is the usual cause of such aortic deviation, syphilis may occasionally be a factor. The occurrence of the condition in twins suggests a congenital factor for the local disposition of the sclerosis.

Esophageal compression can cause dysphagia of varying degrees, which has been known to lead to a fatal issue. One of the author's patients had dysphagia, but this was related to a goiter and not to the compressive effect of the sclerotic aorta upon the esophagus.

To be considered in differential diagnosis are the several congenital anomalies of the aortic arch, mediastinal tumors and cysts, and aneurysm, as well as primary esophageal growths. The aorta, as it crosses the lower thoracic spine, may cause a confusing prominent soft-tissue shadow in the right anterior oblique view.

Five roentgenograms; 1 drawing.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Aortic Origin of the Right Pulmonary Artery. Coling Caro, Victor C. Lermanda, and Harold A. Lyons. Brit. Heart J. **19:** 345–352, July 1957. (C. C., Graduate School of Medicine, University of Pennsylvania, Philadelphia, Penna.)

A single case is reported in which the right pulmonary artery arose from the ascending aorta. Eight other cases, previously described, are summarized in tabular form.

On the plain postero-anterior film the right hemithorax appeared definitely smaller than the left. Both pulmonary arteries were somewhat enlarged and the right hilus was a little higher than the left. The heart was slightly elongated to the left and downward. On angiocardiography the left pulmonary artery opacified from the right side but the right pulmonary vascular tree did not fill until the medium reached the aorta. The actual origin of the anomalous vessel was seen on the angiocardiogram obtained in the right anterior oblique position. Bronchography was essentially negative. Cardiac catheterization yielded normal findings except that the catheter could not be passed into the right pulmonary artery.

Differential pulmonary function studies showed that the right lung did not take up any oxygen from room air but did eliminate some CO_2. On the breathing of pure oxygen, there was some uptake on the right side. On the evidence it was felt that the right lung was capable of function, and surgical correction was therefore attempted. The vessel was severed from the aorta and by a graft was connected to the pulmonary artery. The patient tolerated the procedure well but died in the postoperative period from hemorrhage from an accidental injury to the intercostal artery during surgery, unrecognized at the time.

Embryologically this anomaly is thought to be caused by an asymmetric origin of one of the sixth aortic arches. The authors' case and 2 of the 8 from the literature were associated with patency of the ductus arteriosus.

Four roentgenograms; 2 photomicrographs; 4 diagrams; 1 table. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Pulmonary Vascular Patterns in Pulmonary Hypertension. A. E. Doyle, J. F. Goodwin, C. V. Harrison, and R. E. Steiner. Brit. Heart J. **19**: 353–365, July 1957. (Hammersmith Hospital, London, England)

The pulmonary vascular pattern in pulmonary hypertension of congenital origin was compared with that in a group of cases resulting from mitral stenosis reported on previously (Davies, L. G., *et al.*: Brit. Heart J. **15**: 393, 1953. Abst. in Radiology **63**: 284, 1954). Studies were also made on cases with increased pulmonary flow (left-to-right shunts) but without pulmonary hypertension. Plain films, catheterization, and angiocardiography (including 30 postmortem pulmonary arteriograms) were used, as well as pathological examination when possible.

Definite differences were found in the vascular patterns of the various groups. In mitral stenosis with pulmonary hypertension the main arteries were enlarged, while the branches were narrowed and tortuous in the lower and mid zones but not in the apices. In congenital lesions with left-to-right shunts and pulmonary hypertension, both main arteries and branches were enlarged and tortuous. The smallest branches were narrowed in some instances but these were beyond the range of plain roentgenography or angiocardiography. All zones were equally involved. In congenital heart disease without severe pulmonary hypertension the changes were similar to those in the hypertensive group, in that the main and medium-sized arteries were invariably enlarged. While oligemia at the periphery of the lung usually indicated reduction in, or reversal of, the left-to-right shunt, due to increased vascular resistance, this was not always the case and it was not possible to determine the presence or absence of pulmonary hypertension from the chest film except in very severe cases.

In mitral stenosis with pulmonary hypertension, administration of hexamethonium caused a fall in pulmonary pressure with no significant drop in systemic pressure or cardiac output. On the other hand, in the congenital group there was no drop in pulmonary pressure, or only a slight one, or an accompanying fall in cardiac output.

Eleven roentgenograms; 6 photomicrographs; 1 photograph. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Partial Transposition of the Pulmonary Veins. A. Stecken. Fortschr. a. d. Geb. d. Röntgenstrahlen **86**: 710–720, June 1957. (In German) (I. Medizinische Universitätsklinik und Poliklinik der Charité, Berlin, Germany)

By means of angiocardiography, Dotter, *et al.* (Am. J. M. Sc. **218**: 31, 1949. Abst. in Radiology **54**: 906, 1950) first diagnosed pulmonary venous transposition *in vivo*. In this condition a pulmonary vein, practically always from the right lung, empties into either the vena cava or the right atrium instead of into the left atrium. The abnormal vein is commonly first visualized on the routine postero-anterior roentgenogram of the chest, where it produces a broad saber-like shadow running downward through the right lung parallel to the right border, which it approaches inferiorly. The combination of some congenital weakness with the higher venous pressure resulting from the connection of this vein with the greater circulation predisposes to its large size and its becoming varicose.

Anomalies frequently associated with this condition include aberrant arteries, septal defects of the heart, and defects of the cardiac vascular pedicle. Because of the left-to-right shunt, with a decrease in the quantity of blood available for the left ventricle and the greater circulation, the aorta tends to be small and the right side of the heart proportionately large.

There is a related anomaly of the vena anonyma which yields a characteristic roentgen picture that has been variously described as the cottage-loaf configuration, the figure-of-8 sign, the dumb-bell silhouette, and the mediastinal mustache. The author does not mention the comparable anomaly of pulmonary sequestration.

Two cases are reported. The first patient was a forty-one-year-old female whose chest film revealed a large blood vessel sweeping through the right lung and merging with the cardiac outline at the cardiophrenic angle. The diagnosis was made by means of tomograms following initial suspicion aroused by the routine film. On cardiac catheterization the intravenous catheter passed directly into the anomalous vein near the inferior vena cava. Oxygen saturation studies indicated that there was a blood flow of approximately 7.5 liters per minute from this pulmonary vein into the inferior vena cava, with a total pulmonary circulation of 10.8 liters per minute.

The second case was that of an eighteen-year-old girl. Again the vein was discovered on a routine film. It emptied into the right atrium and was accompanied by an atypical artery arising from the aorta. Hypoplasia of the right hemithorax was also apparent on the roentgenogram. Since the patient exhibited neither symptoms nor disability, the question of surgery did not arise, and no attempt to confirm the diagnosis by catheterization was made.

Thirteen roentgenograms.
WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

A Correlative Study of Peripheral Coronary Pressures and Coronary Arteriography Following Coronary Occlusion. Joseph J. Garamella, Vane P. George, Jr., and Lyle J. Hay. Surg., Gynec. & Obst. **105**: 89–96, July 1957. (J. J. G., 825 Nicollet Ave., Minneapolis 2, Minn.)

This is the report of an interesting investigation in which coronary arteriography was performed in 90 dogs. Coronary pressure studies were carried out in a number of them, and in many the anterior descending branch of the left coronary artery was ligated. Pressure readings and radiographs were made before, during, and, when possible, after the ligations.

Low pressure readings and poor arteriograms after ligation of the vessels indicated that normally the intercoronary collateral circulation and function are rather poor. Serial studies following ligation revealed that the pressure in an occluded coronary vessel returns to normal level within approximately three weeks.

Attempts to produce a chronic progressive occlusion

were not made, since it was felt likely that the intercoronary circulation would expand to bring coronary pressures up to normal levels. However, it was surmised that, even though peripheral coronary pressures were normal, the total coronary reserve would probably be reduced.

Eleven roentgenograms; 1 drawing; 2 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Selective Abdominal Arteriography by Way of the Brachial Artery. F. Morino and A. Tarquini. Radiol. med., Milan **43:** 529–550, June 1957. (In Italian) (Clinica Chirurgica dell'Università di Torino, Turin, Italy)

The authors describe a procedure of abdominal arteriography through a catheter inserted *via* the brachial artery, exposed in mid-arm. The major difficulty arises usually at the aortic arch, and experience has shown that a slightly curved catheter tip is helpful in finding the way (under fluoroscopic guidance) into the descending segment, and then, through the diaphragmatic hiatus, into the abdominal aorta. With further manipulation and rotation, the tip can be made to enter the particular arterial outlet intended for opacification. The injection is begun with Novocain 1 per cent (to minimize spastic phenomena), followed by the organic iodinated contrast medium. After it has been ascertained that the exposed roentgenograms are satisfactory, the catheter is withdrawn, and the rent in the brachial artery is sutured. In a series of 34 patients, on whom a total of 52 abdominal arteriographic studies were completed, there were no serious accidents. Demonstration of the celiac branches (three cases), splenic artery (three cases), renal vessels (seven cases), and superior mesenteric artery (one case) are illustrated.

Additional experience may be necessary to determine the possible hazards of this technic, which seems to be promising so far as its possible diagnostic value is concerned.

Seventeen roentgenograms. E.R.N. GRIGG, M.D.
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Diagnostic Value of Translumbar Aortography. B. J. Koszewski and W. J. Reedy. Circulation **16:** 120–131, July 1957. (Creighton University School of Medicine, Omaha, Nebr.)

No new material is contained in this comprehensive review of the literature on translumbar aortography. The history, technic, and hazards of the procedure are first discussed. Its chief value is the demonstration of the status of the aorta and its branches. Aneurysms, atherosclerosis, anomalies, and occlusions are well seen. In abdominal conditions other than vascular or urologic it is rarely of sufficient value to justify the risk. In complicated urologic cases, however, much additional information may be gained as to the presence of anomalous vessels, renal function, and the existence and even the type of various renal neoplasms. Complications of the procedure are also discussed.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Aorto-arteriography in Obliterative Vascular Disease of the Lower Limbs. T. Philp. Proc. Roy. Soc. Med. **50:** 544–546, July 1957. (Royal Infirmary, Edinburgh, Scotland)

Aorto-arteriography is a procedure by which the lower aorta, its pelvic branches, and the arteries of both legs are examined simultaneously with but one percutaneous aortic injection of contrast material. A single anteroposterior view of the abdomen and pelvis is made first and then, with a manually controlled cassette changer, serial views of both legs.

Obliterative vascular disease of the lower limbs is usually due to one of two conditions:

A. *Atheroma or atherosclerosis:* The vessels usually show tortuosity, diminution of caliber, alternating areas of narrowing and dilatation, irregularity of lumen, and a characteristic roughening or feathering of the walls. Calcification within the walls is a helpful corroborative finding.

B. *Thrombo-angiitis obliterans:* This disease characteristically attacks the distal arteries more severely, but proximal vessels may be involved. Earlier stages are characterized by smooth vessel walls, without tortuosity but with diminution in caliber. As the disease progresses into later stages, some areas of dilatation may occur, the vessel walls become irregular, and mural calcifications appear.

The examination described is important for demonstration of the site and length of obstructing lesions and in bringing to light multiple obstructions. Such information is of value in planning surgical or medical management.

Some complications are briefly described.

Five roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE DIGESTIVE SYSTEM

Radiological Investigation of the Small Intestine in South India. (Value of Non-Flocculating Media). D. E. Paterson. Indian J. Radiol. **11:** 53–69, July 1957. (Christian Medical College, Vellore, Madras, India)

The author reports the results of a small-bowel study in 162 cases in which the chief complaints were loose stools and vague abdominal pain. Various barium preparations were used, and fluoroscopic and roentgenographic observations were made.

The use of ordinary medical barium sulfate suspension gave rise to flocculation patterns that were of little diagnostic significance. The occurrence of these patterns was markedly reduced by the use of so-called nonflocculating preparations.

Among the roentgen findings were a general increase in the caliber of the small intestine together with prominence of the primary transverse mucosal folds and decrease in transit times. As seen in South India, whence the report comes, these observations often indicate motor disturbances that can be relieved by antispasmodics, or a malabsorption syndrome that can be treated by appropriate replacement measures.

The demonstration of localized dilated loops of intestine are strongly suggestive of intestinal tuberculosis or regional enteritis, but their absence does not exclude these conditions. Observation of peristalsis, mobility of the bowel, chest films, and other diagnostic measures are required in such cases.

The author concludes that a careful radiographic study of the small intestine is a rewarding procedure, pointing the way, in South India, to further investigation and treatment in about 90 per cent of cases of suspected small bowel disease. Such disorders in the

clinic at the Christian Medical College, Vellore, constitute about a third of all cases referred for barium study.

Eleven roentgenograms; 1 photograph; 2 diagrams; 5 tables.

JACK E. CARLISLE, M.D.
Shreveport, La.

Giant Duodenal Ulcer. S. F. Herrmann. West. J. Surg. **65:** 239–240, July-August 1957. (740 St. Helens Ave., Tacoma 2, Wash.)

A case is reported to call attention to the fact that a duodenal ulcer may be so large that the crater does not produce the usual diagnostic deformity and the roentgenologist overlooks the ulcer. The patient, a 58-year-old musician, complained of attacks of sudden and severe pain. Pain always returned when sedation was decreased. Roentgen studies were reported negative. Psychotherapy was recommended, but before this could be instituted, the patient had a sudden massive hemorrhage with syncope. There was melena but no vomiting. Operation disclosed an ulcer involving the entire posterior duodenal wall, measuring at least 5 cm. in its longer diameter. The smooth crater penetrated into the pancreas. A posterior Polya gastrojejunostomy was carred out after resection of two-thirds of the stomach. Symptoms were completely relieved.

Of 15 cases of giant duodenal ulcer recorded in the literature, 9 were unrecognized antemortem, and the patients died of hemorrhage.

The Indenture Sign in Acute Exudative Colitis. M. H. Poppel and S. L. Beranbaum. Am. J. Digest. Dis. **2:** 382–386, July 1957. (New York University-Bellevue Hospital, New York, N. Y.)

The indenture sign is the earliest roentgen evidence of the acute exudative phase of colonic infection. It consists in numerous scallopings or indentations, usually equal, caused by swollen mucosal folds extending into the lumen of the bowel and reducing its size. The defect has no sharp margin and the involved area gradually merges with the normal portions. The peaks or serrations are not ulcerations but represent barium extending in between the rather uniformly swollen mucosal folds characteristic of acute exudative inflammation. These spikes are usually equal in size, changing simultaneously with variations in extent and shape of the mucosal folds. The defect may be quite long, and there may be skip areas. The sign is seen particularly well in the postevacuation film.

The indenture pattern is not specific for any disease entity. It was originally described in appendicitis and in lymphogranuloma venereum. In addition to its occurrence in these conditions and in ulcerative colitis, it may be seen in acute diverticulitis and in all other types of acute exudative inflammatory disease.

Eleven roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

The Roentgen-Anatomic Relations Between the Duodenal Bulb and the Common Duct; The Contrast Medium Seen Lateral to the Choledochus after Cholangiography—So-Called Gallbladder Regenerate. V. Buchtala, H. Lang, and Fr. Walter. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 16–22, July 1957. (In German) (Nymphenburger Str. 163, Munich 19, Germany)

Whether the gallbladder can regenerate from the stump of the cystic duct following cholecystectomy has been somewhat problematic ever since the beginning of this century. Some authors believe that a long cystic duct, if left behind following operation, may occasionally dilate and resume the function of a bile reservoir, similar to a gallbladder, but the authors reject the possibility that an organ with anatomical and histologic structure resembling the original gallbladder can ever again be formed.

Since the advent of intravenous cholangiography with Biligrafin (Cholografin), numerous articles have appeared describing various contrast shadows lateral to the common duct following cholangiography. These shadows bear a certain resemblance to the gallbladder and therefore the old problem of gallbladder regeneration has been revived.

The authors present 4 cases with such questionable contrast shadows. By means of a gastrointestinal check-up with barium following cholangiography, they prove that the questionable shadows represent contrast medium that has followed a retrograde pathway from the papilla of Vater into the duodenal bulb. With periduodenal adhesions following cholecystectomy, the bulb may remain filled for a considerable period.

Ten roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Operative Cholangiography in Surgery of the Biliary Tract. Meyer Corff. Am. J. Surg. **94:** 9–18, July 1957. (Albert Einstein Medical Center, Northern Division, Philadelphia, Penna.)

The author reports on 100 consecutive cases treated during 1955, in each of which exploration of the common duct and operative as well as postoperative cholangiograms were obtained. No increase in postoperative morbidity or mortality was noted as a result of these measures, although some authors mention the possibility of untoward sequelae such as reflux pancreatitis and chemical cholangitis.

Stones were found in the common duct in 47 per cent of the 100 patients. Six patients in whom cholecystectomy had previously been done all showed stones in the common duct. Of the 94 patients who underwent cholecystectomy, 93.6 per cent had stones in the gallbladder.

The author's indications for exploring the common duct are dilatation of the duct, jaundice, stones demonstrated by pre-choledochostomy cholangiograms, small stones in the gallbladder, and palpable stones in common duct. Fifty per cent of his patients were explored for dilatation of the common duct, but only 28 per cent were explored because of jaundice. Twenty-seven per cent of patients had stones in the common duct without jaundice. Dilatation of the common duct should be the chief indication for exploration or operative cholangiography, but in the author's experience this indication for exploration was the least rewarding in discovering stones.

The common duct was explored because of jaundice in 28 per cent of patients. In 68 per cent of these cases the jaundice was due to stones in the common duct. In 20 per cent the cause of jaundice was undetermined. In 9 per cent pancreatitis was responsible, and in 3 per cent an obstructive tumor at the lower end of the common duct.

Operative Cholangiography: Thirty pre-choledochostomy cholangiograms were obtained in 28 cases. In 8 of the 9 cases reported as showing stones by this

study, the diagnosis was proved at operation; there was 1 false positive report. The percentage of false negative reports was 11.7. Fourteen per cent of the films were classed as unsatisfactory.

The post-choledochostomy cholangiogram was taken through a T-tube in the common duct after it had been explored but before the abdominal cavity was closed. Of 81 cholangiograms in 72 patients, 62.9 per cent were normal. In 14.8 per cent of cases no stones were seen but no contrast material entered the duodenum, probably as a result of spasm of the sphincter of Oddi, possibly due to administration of morphine preoperatively. In 13.6 per cent of cases films were questionable as to diagnosis, and in 3 of these cases stones were seen on the postoperative films. In 4.1 per cent of cases a false negative report was given.

Postoperative cholangiography was done routinely in all cases, seven to ten days after operation. One hundred and twenty examinations were done in the 100 patients; 4.1 per cent of these were classified as unsatisfactory.

The recorded occurrence of retained stones in the common duct ranges from 2 per cent to 22 per cent, in cases where post-choledochostomy cholangiography was not carried out. In the present series the author reports only 10 per cent retained stones in the common duct after post-choledochostomy cholangiograms, and operative cholangiography was directly responsible for detecting stones which were missed on exploration of the common duct in 5 per cent of the cases.

Of the 10 cases which showed retained stones, 3 had negative post-choledochostomy film reports. In 2 cases the pre-choledochostomy films showed stones which were removed but no post-choledochostomy films were taken. In 3 cases the reports on the operating room films were questionable and are classed as false negative reports. In 2 cases the post-choledochostomy films showed hepatic stones which could not be reached, and by the time the postoperative study was made, the stones had dropped into the common duct and the hepatic ducts were clear.

It appears that operative cholangiography, particularly the post-choledochostomy film study, is of considerable value in the detection of retained common duct and hepatic duct stones. This is particularly true for the younger inexperienced surgeons.

Five roentgenograms; 4 tables.

JOHN P. FOTOPOÚLOS, M.D.
Hartford, Conn.

The Technic of Peroperative Cholangiography Using the Fluoroscopic Image Intensifier. J. Lackner and L. Völkel. Röntgen-Blätter **10:** 119–128, April 1957. (In German) (J. L., Städtische Krankenanstalten, Bremen, Germany)

The "portable" version of the Phillips image intensifier (marketed in Germany under the name of Müller BV 20) was originally intended for orthopedic work. With the roentgen tube placed beneath a special radiolucent surgical table, after slight modification and adaptation of a semi-automatic changer of electrical data for spot-films, the device has been successfully employed for fluoroscopic guidance during cholangiography performed in the course of laparotomy. Since the amount of contrast material to be injected can be adequately determined by fluoroscopic control, and since dark adaptation is not required and exposure to radiation is fairly limited, the procedure appears to be very satisfactory. It may deserve trial on a large scale, to detect any possible shortcomings.

Two roentgenograms; 4 photographs; 3 drawings; 1 table.

E.R.N. GRIGG, M.D.
Cook County Hospital, Chicago

Annular Pancreas: Errors in Diagnosis and Treatment of Eight Cases. William H. Mast, Lewis D. Telle, and Robert O. Turek. Am. J. Surg. **94:** 80–89, July 1957. (W. H. M., 3716 Euclid Ave., Cleveland 15, Ohio)

The term "annular pancreas" is applied to a developmental anomaly in which a ring of pancreatic tissue encircles the descending portion of the duodenum. The presence and severity of symptoms depend upon the degree of duodenal obstruction. In the newborn, persistent jaundice may be caused by compression of the common bile duct by the annulus or the distended duodenum. Duodenal obstruction may be complete, attended by profound electrolyte disturbance and dehydration. In older patients the onset of symptoms may be sudden and simulate acute cholecystitis or perforated peptic ulcer. Such symptoms are usually precipitated by the onset of acute pancreatitis in the annulus due to obstruction of the annular duct. Retention of food in a dilated pouch proximal to the annulus interferes with normal function of the pyloric sphincter and may be a stimulus for antrum hyperfunction with resultant hypersecretion and hypermotility. More often the complaints are vague and poorly defined.

Careful roentgenographic studies are most important in the diagnosis of annular pancreas. Infants frequently exhibit signs of high intestinal obstruction during the first week of life. A "double-bubble" sign characterized by dilatation above and below the annulus with the stenotic portion clearly outlined has been described. Opaque media may be used to demonstrate the anatomy of the descending duodenal loop. The authors describe three characteristic signs which were found in their 8 cases. The first is the smooth annular filling defect of the second and occasionally third portion of the duodenum. The second is a varying degree of symmetric dilatation of the duodenum proximal to the constriction, and the third is the fluoroscopic evidence of reversed peristalsis in the duodenum proximal to the obstruction.

Differential diagnosis should include duodenal diverticula, aberrant pancreas, tumor of the duodenum, inflammatory changes, and compression of the duodenum by the superior mesenteric vessels.

Surgical intervention for treatment of annular pancreas should be undertaken only when there are definite symptoms resulting from obstruction of the duodenum and/or the common bile and pancreatic ducts. The preferred technic in infants would seem to be gastroenterostomy. In an adult gastroenterostomy with transabdominal vagotomy is the procedure of choice. Serious complications as well as failure to relieve the patient's symptoms have been reported following resection of the annulus. Pancreatic fistula has occurred frequently, and duodenal obstruction has persisted. The scarring and narrowing of the duodenum at the site of obstruction are usually pronounced, and resection of the ring of pancreas cannot be expected to relieve the obstruction. If the annulus produces compression of the common bile duct and jaundice in an infant, cholecystoduodenostomy should be performed. In the adult, obstructive jaundice due to compression

of the common bile duct by the annulus may be treated the same way or a Roux-Y type of diversion of the common bile duct may be considered.

The authors' 8 patients included 6 males, aged five weeks, twenty-four, thirty-four, fifty-seven, fifty-nine, and sixty-six years, and 2 females of thirty and thirty-nine years.

Five roentgenograms; 2 photographs; 2 diagrams.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Roentgen Findings in Leiomyosarcoma of the Pancreas. S. B. Feinberg, A. R. Margulis, and P. Lober. Minnesota Med. **40:** 505–506, July 1957. (University Hospitals, Minneapolis 14, Minn.)

A case of leiomyosarcoma of the pancreas in a 14-year-old boy is reported, with particular attention to the roentgen and pathologic findings. Although the condition is unusual, it is important that it be considered in the differential diagnosis of pancreatic masses. An anteroposterior view taken during excretory pyelography disclosed extrinsic compression of the right kidney without displacement, superimposed mass margins, and displacement of the duodenal bulb to the right. The lateral view of an upper gastrointestinal series demonstrated the posterior mass flattening and displacing the second portion of the duodenum anteriorly. This in itself pinpointed the mass, since the second portion of the duodenum is a retroperitoneal structure whose mesentery has been resorbed and only the parietal peritoneum covers the anterior duodenal surface. An oblique view of the stomach showed the picture characteristic of a lesion of the head of the pancreas: widening of the duodenal loop and anterolateral displacement of the antrum.

Laparotomy revealed a large round encapsulated tumor to the left of the duodenum in the head of the pancreas, extending to the left of the superior mesenteric vessels. Only a small segment of normal pancreas remained, and a radical pancreato-duodenotomy was done. Pathologic examination showed a large rounded tumor measuring 11 × 10 × 9 cm. in the head of the pancreas. This was believed to be a smooth muscle tumor, considered malignant because of pleomorphism of the cells and evidence of growth activity. There was, however, no evidence of spread beyond the primary location.

Three roentgenograms; 2 photomicrographs.

Fluoroscopic Sign of Pancreatic Disease. Robert Shapiro. Am. J. Digest. Dis. **2:** 387, July 1957. (Hospital of St. Raphael, New Haven, Conn.)

As an aid in the roentgen diagnosis of abnormalities of the pancreas the author reports a fluoroscopic sign related to abnormal physiologic behavior of the horizontal portion of the duodenum, namely, persistent retrograde peristalsis.

The exact mechanism underlying the abnormal peristalsis is not clear. The sign is not pathognomonic of carcinoma of the pancreas but has been observed in mucosal lesions of the third portion of the duodenum as well as in inflammatory and other neoplastic retroperitoneal diseases. This sign will frequently enable the radiologist to contribute to the early diagnosis of a group of lesions commonly overlooked or at best discovered very late.

THEODORE E. KEATS, M.D.
University of Missouri

THE MUSCULOSKELETAL SYSTEM

Roentgenographic Recognition and Differentiation of Parosteal Osteogenic Sarcoma. G. Melvin Stevens, David G. Pugh, and David C. Dahlin. Am. J. Roentgenol. **78:** 1–12, July 1957. (Mayo Clinic, Rochester, Minn.)

Parosteal osteogenic sarcoma is an unusual type of primary malignant, densely ossified tumor of bone that arises and proliferates from a juxtacortical site. Nineteen examples were assembled from the 2,300 primary bone tumors seen at the Mayo Clinic up to May 1956. The average age of the patients when the tumor was discovered was thirty years.

Typically the history is of a slowly growing, firm, painless mass that eventually limits the motion of the joint; a dull ache may develop. There is a strong tendency to recurrence following excision. There is no sex predominance. The prognosis is favorable: 13 of the 19 patients were alive at the time of the report, and for 5 who died of metastases, the average longevity was twenty years. Local excision followed by amputation was the usual treatment.

Pathological aspects are discussed. Biopsy may need to be repeated, since many portions of the tumor are benign, making the pathologist's task difficult.

The characteristic site of involvement is a long tubular bone in general and the popliteal surface of the distal femur in particular. There is a tendency to encircle the shaft of the bone, as is best demonstrated by stereoscopic films. The tumor is probably of periosteal origin and is firmly attached to the cortex along a part of its base, to grow in an enveloping fashion close to the shaft, but not attached to it. As a result, a free space of from 1 to 3 mm. exists between the tumor and the cortex. The roentgenographic outline of the mass is lobular or it may have a rolling convex border. The density is that of the adjacent bone. A distinctive feature is the lack of periosteal elevation, with the cortex intact and not invaded in the early stages. Similar appearing lesions include myositis ossificans, osteochondroma, parosteal ivory osteoma, sclerosing osteogenic sarcoma, ossifying hematoma, and exuberant callus.

Due to the tendency to encircling growth, local excision has, as a rule, been followed by recurrence, and amputation is therefore the treatment of choice. A typical history and characteristic roentgenographic findings are felt to be reliable enough to warrant amputation in spite of absence of histopathologic evidence of malignancy.

Twenth-three roentgenograms.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Fluoride Osteosclerosis. Clyde A. Stevenson and A. Ralph Watson. Am. J. Roentgenol. **78:** 13–18, July 1957. (C. A. S., 407 Riverside Ave., Spokane, Wash.)

The authors present an historical review of fluoridation from 1908 to the present time and offer a series of 23 cases of fluoride osteosclerosis gleaned from a review of 170,000 routine roentgen examinations of the spine and pelvis made on patients from Texas and Oklahoma, where the fluoride content of the drinking water is known to be high. The 23 cases had nothing in common but roentgenographic change in the osseous system. There was no correlation between the roentgen

findings and any of the patient's disease processes or symptoms. A fluoride content of 4 parts per million (ppm.) was found to be required for the development of fluoride osteosclerosis but no harmful change was noted with drinking water having a content of up to 8 ppm.

Roentgen diagnosis of fluoride osteosclerosis is based on Roholm's observations in workers exposed to large doses of fluorides inhaled as cryolite dust (Fluorine Intoxication. London, H. K. Lewis & Co., 1937). He reported changes ranging from slightly increased bone density in the spine and pelvis, with roughened and blurred trabeculae, in the early stages, to marked increase in bone density with involvement of the ribs and extremities, and with ligamentous calcification. The changes observed by the present authors were slightly increased bone density, evenly distributed throughout the vertebral bodies and appearing bilaterally and symmetrically in the pelvis. There is a definite but slight "ground-glass" appearance. The most advanced changes encountered were a chalky-white appearance of the spine and pelvis plus a slightly increased density and coarse trabecular pattern in the ribs. Of special interest was calcification of the sacrospinous and sacrotuberous ligaments. In the presence of sclerotic bone changes, ligamentous calcification is helpful in making a diagnosis of fluoride osteosclerosis.

Seven roentgenograms; 1 table.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Idiopathic Hypercalcemia. J. A. Shiers, E. B. D. Neuhauser, and J. R. Bowman. Am. J. Roentgenol. **78:** 19-29, July 1957. (E. B. D. N., 300 Longwood Ave., Boston 15, Mass.)

Seven previous cases of idiopathic hypercalcemia are cited, and 4 more, including one in a cretin, are described. The clinical manifestations of idiopathic hypercalcemia are in part directly due to the raised serum calcium level, which results in muscular weakness, hypertonia, anorexia, vomiting, and failure to thrive. With prolonged elevation of the serum calcium permanent changes occur, such as marked retardation of growth and damage to the brain, kidneys, and heart. Associated anomalies, which cannot be directly related to hypercalcemia, are frequently observed.

In a number of cases a characteristic facies has been described, with prominent eyes, often mongoloid lids, hypertelorism, big mouths, small pointed heads, receding foreheads and chins with large low-set ears.

Roentgen findings consist of osteosclerotic changes in the form of bands or zones which shade off gradually into normal bone. These are found in all bones but are particularly apparent in the base and frontal regions of the skull, the vertebral bodies, the carpal bones, and the epiphyses and ends of the shafts of the long bones. The changes are primarily in the spongiosa. The increased bone density may be amorphous or due to thickening and coarsening of the individual trabeculae without disturbance in the pattern. There is impaired bone formation at the ends of the long bones, with cupping similar to that in rickets and osteoporosis. The epiphyses may be recessed into the ends of the long bones as if pressed into them.

Retardation of bone development is a feature of the disease. Despite the increased density, the bones are soft and may be bowed by the hypotonic muscles. Ectopic soft-tissue calcifications are most commonly seen in the renal parenchyma, blood vessels, brain, intermuscular planes, and in the bronchi.

Adequate clinical roentgen examination should leave little room for doubt as to the diagnosis. The clinical and roentgen findings may simulate those of hypervitaminosis D and the authors suggest that hypersensitivity to vitamin D may play an etiologic role.

Nine roentgenograms, 1 photograph.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Ochronosis. M. M. Thompson, Jr. Am. J. Roentgenol. **78:** 46–53, July 1957. (316 Michigan Ave., Toledo, Ohio)

A sixty-three-year-old white male entered the hospital in 1946 with progressive stiffness in all joints and muscles, dating from 1931. Roentgenograms of the spine showed osteoporosis, extensive ankylosis of the vertebral bodies and articular facets, disk calcification, and narrowing of the intervertebral disk spaces. Roentgenograms of the pelvis, dated 1946, demonstrated osteoarthritic changes in the hips, fusion of the sacroiliac joints and of the symphysis pubis, and calcification about the ischial tuberosities, all of which were progressive since 1937. Progressive and severe osteoarthritic changes in the knee roentgenograms were also noted. The cartilages of the ears were extensively calcified. The peroneal and tibial tendons also showed calcification, clinically. The voided urine specimen turned black on standing in sunlight, and the diagnosis of ochronosis was confirmed by the finding of homogentisic acid in the urine. A biopsy from the tendon in the leg yielded pigment consistent with ochronosis.

Calcification of the intervertebral disks is not by itself pathognomonic of this condition, since it can occur also in arthritics. The associated ankylosis and lack of massive spurring, according to the author, are not likely to be seen in arthritics.

Eleven roentgenograms.

DAVID D. ROSENFELD, M.D.
Fontana, Calif.

Osseous Echinococcosis: Radiological Aspects. Federico García Capurro. Acta radiol. interam. **6:** 127–139, July–September 1956. (In Spanish) (Facultad de medicina, Montevideo, Uruguay)

After a brief historical summary of the pathologic anatomy and the clinical signs of echinococcosis involving bone, the author gives a complete description of the radiographic characteristics of the lesions as found in long and flat bones and in the vertebral column. He discusses, also, the complications, including fractures, hydatid collections of bony origin, and inflammatory lesions, and the decisive signs for differential diagnosis. The sign of greatest value, which may also be called a specific sign of this osseous affection, has been designated paravertebral costal erosion. The intervertebral disks are preserved, except in very advanced cases.

Fractures constitute the most frequent complication, occurring most frequently between the ages of thirty and forty years. They are usually painless unless the process is infected. They are not accompanied by ecchymosis and there is no frank crepitation. According to the literature, these fractures do not consolidate well, but the author has observed repair in a number of cases.

Even though one lives in a country where this lesion is rare, it is well to be on the lookout for it.

Nineteen illustrations show the characteristic aspects of the lesions.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

Conditions Involving the Hemopoietic System Resulting in a Pseudorheumatoid Arthritis; Similarity of Multiple Myeloma and Rheumatoid Arthritis. John S. Davis, Jr., Frederick C. Weber, and Harry Bartfeld. Ann. Int. Med. **47**: 10–17, July 1957. (J. S. D., Jr., 135 East 65th St., New York 21, N. Y.)

Cases of multiple myeloma in which deposits of amyloid occur are associated with swelling, pain, and limitation of motion of the adjacent joints. This picture can lead to a clinical diagnosis of rheumatoid arthritis which may be adhered to for years before the true nature of the condition is recognized.

Twenty-six cases of multiple myeloma have been seen at St. Luke's Hospital (New York) since 1931. The first symptom in 22 of these cases was joint pain, generally involving the spine. Arthritis of some type was the primary diagnosis in 16. Two of the latter were diagnosed and treated for a long period as rheumatoid arthritis. In addition, one case of Hodgkin's disease and one case of erythremic myelosis were diagnosed as rheumatoid arthritis and treated accordingly. These 4 cases are reported here.

The definite presence of amyloid substance in and about the joints suggests that deposits of this protein may give rise to the symptoms and signs of rheumatoid arthritis. It is ventured that, in some cases, rheumatoid arthritis may be caused by an abnormality in protein metabolism, resulting in the initial deposition of some protein, either amyloid or other, followed by reactions in synovial and other tissues of the joints involved.

Two roentgenograms; 1 table.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Sesamoid Bones in the Differential Roentgen Diagnosis of Fractures. Gy Justus. Radiol. med., Milan **43**: 575–579, June 1957. (In Italian) (Ospedale centrale, Nográd, Hungary)

Comparison with the opposite side is of little value in the differentiation of fractures from sesamoids, because the latter are often asymmetrical. More helpful is the fact that sesamoids are commonly located in the vicinity of joints. Sesamoid bones contain a spongy center surrounded by a cancellous periphery, which is thin but of uniform width. As a rule, the corticalis of osseous chips is irregular and especially conspicuous by its absence along the fracture line. In some cases correlation with the clinical findings (history of type, site, and strength of traumatic episode, local tenderness, and functional impairment) will be necessary; under exceptional circumstances, final diagnosis cannot be established until after progress examinations.

Eight roentgenograms; 1 drawing.

E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

Prematurity and Rickets. S. Eek, L. H. Gabrielsen, and S. Halvorsen. Pediatrics **20**: 63–76, July 1957. (S. E., University Clinic, Rikshospitalet, Oslo, Norway)

It has recently been suggested that human milk may not be the ideal food for early infancy. Studies have shown that cow's milk or human milk supplemented with additional calcium and phosphorus produce higher blood levels of these two elements. In order to determine whether it might be possible to reduce the relatively high incidence of rickets in premature infants, an experimental feeding study was carried out. Sixty-nine premature infants were placed in three feeding groups—human milk, cow's milk, and human milk supplemented with dried cow's milk—and chemical, clinical, and radiologic studies were performed.

It was found that serum calcium and phosphorus levels were highest in the cow's milk group, and about equal in the other two. Clinically, no rickets was encountered. General growth and development were not significantly different in the 3 groups. Neither did there seem to be any correlation between the x-ray findings and the clinical and chemical findings.

At birth all the premature infants showed, roentgenographically, well defined, rarefied areas at both ends of the metacarpals and long bones of the forearm. These became less well defined from week to week and disappeared by the seventh week. Periosteal double contours, which are regarded as early signs of improved mineralization, developed on the ulna and radius at from two to seven months. They generally appeared latest in the human milk group.

The authors conclude that the risk of rickets probably is not as great as heretofore suggested, and is probably the same whether the infants receive human milk or cow's milk.

Twenty roentgenograms; 26 diagrams; 4 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Comparative Histologic and Roentgen Studies on Human Bone Tissue. U. Gück. Fortschr. a. d. Geb. d. Röntgenstrahlen **86**: 728–740, June 1957. (In German) (Gabrielenstr. 60, Berlin-Tegel, Germany)

The author has made a study of methods of measuring the quantity of calcified bone present in biopsy specimens, in the hope of obtaining more accurate diagnosis in the decalcification osteopathies. The three most common osteopathies—osteomalacia, osteoporosis, and fibrous osteodystrophy—all present characteristic histologic and roentgenologic features. Osteomalacia is characterized by large quantities of osteoid tissue in which the protein ground substance is so disturbed by the lack of vitamin D that it cannot lay down calcium. In osteoporosis the ground substance is normal, but the rate of bone formation is diminished and the breakdown of the old bone is relatively increased, while large portions of the bone are likely to appear normal histologically. Two types of osteodystrophy may be recognized: in the renal type the osteoid tissue is increased in quantity and never ossifies; in the hyperparathyroid type there is markedly increased osteoclastic activity, with a relative increase in the osteoid tissue and a secondary marrow fibrosis.

For the diagnosis of a calcipenic osteopathy on the routine roentgenogram, loss of calcium must amount to 10 to 30 per cent. Physical methods of roentgen measurement are much better and can be used on biopsy specimens for diagnosis. Eighteen bone cylinders were removed by biopsy technic from recently deceased individuals. Specimens were judged on the basis of the histology of the compacta, corticalis, and spongiosa. With the microscope, the quantitative relationship of osteoid to bone was calculated. Measure-

ments were made with a single exposure of all 18 specimens upon a film which included an aluminum ladder. Each segment was then studied by the method of Balz, Birkner, and Wachsmann (Strahlentherapie **97:** 382, 1955. Abst. in Radiology **66:** 807, 1956), in which the absorption from an x-ray beam is measured with a thimble chamber. From this last calculation, the aluminum-bone ratio was calculated to give a precise number for study purposes.

The findings by both the simple film method and the aluminum-to-bone ratio in 16 of the specimens showed very marked agreement with the histologic pattern. Two cases deviated. In both, the bone under question was somewhat loculated and the osteoporosis was undoubtedly more or less irregularly distributed throughout the specimen.

In view of this agreement, the author indicates that a bone biopsy, whenever a question of a metabolic osteopathy is raised, would be of value. If the proper equipment is available, the roentgen studies of the biopsy specimen may be done along with the roentgenologic examination.

Thirty-two roentgenograms; 4 photomicrographs; 1 photograph; 25 drawings; 3 tables.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

X-Ray Visualization of the Intervertebral Disk. Robert E. Wise, W. James Gardner, and Robert B. Hosier. New England J. Med. **257:** 6–10, July 4, 1957. (R. E. W., Lahey Clinic, Boston, Mass.)

The technic employed by the authors for visualization of the intervertebral disks is that described by Lindblom (Acta radiol **34:** 321, 1950. Abst. in Radiology **57:** 612, 1951), the "double needle" method. Diodrast is used as the contrast agent in 0.5 to 2 c.c. amounts of 35 per cent solution. Lateral films are taken after each injection with the needles in place, and a postero-anterior view is then obtained. Diagnostic criteria include the degree of pressure necessary to inject the Diodrast, the nature and severity of pain produced at injection, the pattern of the contrast material in the disk, and the correlation of all of these factors with the history and physical findings.

The normal disk will accept only a small amount of contrast material under high pressure and will show a characteristic biloculated appearance in approximately the center of the intervertebral space. Pain of sciatic type on injection is of some diagnostic importance but may be misleading in that it may fail to be produced in degenerated disks with a torn annulus and ready escape of the contrast agent. In addition to the basic normal discographic pattern, the authors describe "a degenerative type," with the contrast medium spread throughout the confines of the disk in a flattened, disorganized manner, usually with associated narrowing of the interspace. Another abnormal pattern is that of tear, or rupture, of the annulus with escape of the contrast material beneath the posterior spinal ligaments. Extrusion of the disk material will usually be manifest as an indentation in the column of contrast material along the posterior aspect of the vertebral body.

Data are derived from 165 patients in whom 339 disks were injected. Sixty-eight of the patients underwent surgery and 107 disks were explored. Radiologic and surgical agreement was obtained in 98 disks or 92 per cent of those explored. There were 5 false positive and 4 false negative radiologic studies. A review of these errors in diagnosis shows that almost all were associated with the "degenerative disk pattern," in which small protrusions were improperly evaluated or pain at injection was incorrectly interpreted. It is felt, however, that this analysis of the proved errors represents mostly inherent deficiencies in the procedure which may not be overcome with increased experience.

Advantages of diskography over myelography include direct demonstration of disk degenerations or protrusions; rapid absorption of a nontoxic medium, not requiring removal after the examination, and avoidance of radiculitis and arachnoiditis. Occasionally a severe exacerbation of sciatica may be produced, but usually this means that an abnormal disk has been injected and surgery is required.

It is concluded that diskography is indicated in those cases in which the myelogram is apparently normal but clinical findings and symptomatology still suggest disk disease. The procedure is to be "preferred to exploration in the face of a negative myelogram."

Six roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Clay Shoveller's Disease in Adolescents (Schmitt's Disease). A Report of Two Cases. W. J. Weston. Brit. J. Radiol. **30:** 378–380, July 1957. (Hutt Hospital, Hutt, New Zealand)

Schmitt in 1941 first called attention to changes in the spinous process of the first dorsal vertebra in boys between the ages of fourteen and sixteen. The radiographic evidence consisted of edema over the spinous process and some osteoporosis of the bone adjacent to the apophysis, although occasionally bone sclerosis in this area may be encountered. The apophysis itself may be irregularly shaped and displaced in a caudal direction. The end-result radiographically is the return to normal bone structure but with persistence of an abnormal shape of the spinous process at its distal end. The condition is believed to represent a juvenile stage of clay shoveller's disease.

The author reports 2 similar cases. All patients with this disease give a history of injury or increased exertion or activity over this area prior to the onset of symptoms. With avoidance of further strain in the area, healing takes place in three to four months. At times, following healing of the process, the apophysis remains ununited with the remainder of the spinous process. The condition is felt to represent an aseptic bone necrosis due to the trauma.

Four roentgenograms; 8 diagrams.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Roentgenographic Diagnosis of Spinal Tumors. Arthur S. Tucker, Bisamai Aramsri, and C. Robert Hughes. Am. J. Roentgenol. **78:** 54–65, July 1957. (A. S. T., Department of Radiology, University Hospitals, Cleveland 6, Ohio)

The authors discuss the problems relating to the roentgenographic diagnosis of spinal tumors based on a review of 96 cases studied at the Cleveland Clinic from 1949 to 1955 inclusive plus 71 cases previously reported by Hannan, Hughes, and Mulvey (Radiology **53:** 711, 1949).

Primary spinal tumors, in contrast to metastatic lesions, are in most instances not evident on plain roentgenograms of the spine. There may be revealed erosion or infiltration of bone, but rarely calcification or the

presence of an extraspinal mass. Special procedures, including laminagraphy, are especially helpful in establishing a diagnosis. One-third of the presented cases showed abnormalities on plain roentgenograms. Myelography aided in making the proper diagnosis in 76 of the authors' 96 cases. It is most likely to be helpful with intradural lesions, 47 out of 56 intradural tumors having been diagnosed by this method. The iodized oil may be introduced into either the lumbar subarachnoid space or the cisterna magna. Selected cases were studied by air myelography or diskography.

Special care is urged in making the diagnosis of spinal tumor. Errors in technic, effects of trauma, infections, arthritis, protruded intervertebral disks, and congenital anomalies have all led to mistaken interpretation of myelograms.

Forty-four roentgenograms; 2 tables.

NORMAN L. ARNETT, M.D.
Fontana, Calif.

Roentgen-Anatomic Studies of the Pelvic Girdle in the Newborn. Z. Zsebök. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 23–33, July 1957. (In German) (Üllöi J 8, Budapest, Hungary)

This study is based upon the x-ray examination of 50 dead fetuses ranging from three months gestation to nine months and of 1,000 newborn babies. The purpose was to find early x-ray signs that would indicate a congenital dislocation of the hip or a tendency toward it, thus facilitating the earliest possible treatment.

The author describes three criteria which strongly suggest a dysplasia of the hip joint or a preluxation.

The first one concerns the angle of the acetabular roof. In accordance with the method described by Hilgenreiner, the author draws a horizontal line across the pelvis through the middle of the acetabula (the so-called Hilgenreiner line). Another line is then drawn along the upper half of the bony outline of the acetabulum (the upper branch of the "Y" of the acetabulum). The angle formed by this line with the Hilgenreiner line is called the angle of the acetabular roof ("Pfannendachwinkel"). According to the author's findings, this angle in a normal male newborn infant measures 27.34°, and in a female 29.61°. With an angle of more than 35° a dysplasia or a preluxation is to be expected.

The second criterion is the distance between the upper bony edge of the diaphysis of the femur (the epiphysis, being cartilaginous, is not demonstrable) and Hilgenreiner's line. This distance averages 10.41 mm. in the male and 9.15 mm. in the female but is subject to variations with age. It is usually shortened in congenital dislocation of the hip.

The third criterion concerns the position of the head of the femur in relation to the center of the acetabulum. The author has observed, in a study of many specimens of fetal femora and of femora of the newborn, that the angle between the shaft and the neck is 125° and not 148° as stated in many medical books. Ordinarily the femoral head and neck of the newborn, being cartilaginous, cannot be shown on the x-ray film. If, however, a straight line is drawn in the longitudinal axis of the shaft of the femur, a second line drawn from the upper end of the first where it strikes the end of the bony shaft, at an angle of 125° to the shaft, should reach the middle of the acetabulum. If it reaches the acetabulum above the middle, a dysplasia or a subluxation is strongly indicated. It is assumed in these studies that the femur on the x-ray film is parallel to the long axis of the body. If the femur is in abduction or adduction, a correction must be made which is described in the text.

Twenty-one roentgenograms; 1 table.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Short Leg—Tilted Pelvis. A. Edinger and F. Biedermann. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 754–762, June 1957. (In German) (A. E., Königstr. 35, Stuttgart N, Germany)

In the authors' clinic, lumbosacral roentgenograms are taken on 30 × 90-cm. films at 3 meters, with the patient standing with both feet together, great toes touching, and the legs as straight as possible. Leg length is measured on these films in terms of height of the hip joint. The legs are also measured clinically with the aid of a fluoroscope to locate the greater trochanters.

Three hundred sixty-four successive patients, without regard to clinical diagnosis, were measured both radiographically and with the fluoroscopic clinical method. In 337 of this number the two forms of measurement agreed: 175 patients showed both legs of the same length, in 32 the left leg was shorter, and in 114 the right leg was shorter. In 27 instances the clinical and the roentgen measurements disagreed. This disagreement raised the question as to whether a leg can be functionally short yet anatomically normal. The authors believe that it can.

One leg may appear roentgenographically to be short, when it really is not, by reason of rotation of the pelvis and pelvic tilt with or without muscle spasm. The abnormal pelvic tilt can be reproduced clinically in normal patients since it occurs as a phase of normal gait, as well as in shifting of weight-bearing when all the weight is placed on one leg. A patient in the military "at-ease" posi on typically shows a tilting of the pelvis. Incident : ly, these pelvic tilts are frequently associated with a scoliosis of the lumbar spine, which follows a certain patte n in that the convexity of the scoliosis is toward the lowermost side of the pelvis. Regardless of the cause of the obliquity of the pelvis, the leg when measured o1 a roentgenogram will appear to be short. The authors try to make a case for an entity consisting of a tilted pelvis, a lumbar scoliosis, and a functionally short leg.

Eleven roentgenograms; 7 drawings.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Ost oid Osteoma of the Hand and Wrist. Norman L. Dunit , Paul R. Lipscomb, and John C. Ivins. Am. J. Surg. **4:** 65–69, July 1957. (Mayo Clinic, Rochester, Minn.)

Four cases of osteoid osteoma of the hand and wrist are pre ented, 1 of which was marked by localization in the triquetral bone, a site which had never before been reported. The roentgenographic findings are characteristic, showing the nidus as a small round or oval area (usual y less than 1 cm. in diameter) which may be either radiopaque or radiolucent. It has been stated that early in the process the nidus is radiopaque with no surrounding sclerosis, but as it becomes more mature, resorpt on takes place and the picture becomes that of a radiolucent area surrounded by a sclerotic area of varying size (Jaffe: Radiology **45:** 319, 1945).

Eight roentgenograms; 2 photographs; 1 photomicrograph; 1 drawing.

Peritendinitis Calcarea of the Hand and Wrist. James F. Martin and Byron G. Brogdon. Am. J. Roentgenol. **78:** 74–85, July 1957. (North Carolina Baptist Hospital, Winston-Salem, N. C.)

The authors report 10 cases representing their experience with peritendinitis calcarea of the wrist and hand. They emphasize the importance of roentgen examination in the differential diagnosis of localized, acute, and subacute lesions in this region. A discussion of the clinical findings, etiology, pathology, and treatment is presented.

Peritendinitis calcarea is believed to be a self-limiting disease with a low incidence of recurrence. It is prone to spontaneous remission. The diagnosis can be firmly established when there is roentgen demonstration of calcium deposits in the soft tissues of the symptomatic area. The authors present radiographs of excellent quality and stress the need for careful selection of the proper tangential and oblique projections. The calcifications are typically amorphous in character, varying in contour and configuration. They may appear as linear shadows or as punctate areas. Dense, globular, homogeneous deposits are also common.

Successful management with roentgen therapy in the acute phase is reported. Treatment was given with deep therapy technic to the area of pain and redness. The reported factors were: 220 kv, 15 ma, half-value layer 1.3 mm. copper, target-skin distance 50 cm. The dose varied from 50 to 150 r (skin dose) delivered every other day for five to eight days, for a total skin dose of 450 r. Complete disappearance of calcium and relief of pain occurred in almost all cases.

Twenty-four roentgenograms.

NORMAN L. ARNETT, M.D.
Fontana, Calif.

Juvenile Osteomalacia of the Terminal Phalanx of the Little Finger. F. Schmid. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 766–770, June 1957. (In German) (Bergheimer Str. 40, Heidelberg, Germany)

Congenital finger deformities are commonly seen in early childhood. The most frequent abnormalities are a microdactyly of the terminal phalanx of the thumb and a brachydactyly of the middle phalanx of the fifth digit. The latter alteration results in a radiovolar deviation of the fingers, sometimes termed a clinodactyly. The deformity tends to correct itself with growth.

In contrast with this congenital form of clinodactyly, there is a rare acquired form in which the disease process originates not in the middle phalanx but in the terminal phalanx. This deformity has been previously described in the literature under such terms as: hooked deformities of the little finger, bilateral curved fifth fingers, and dystrophy of the fifth finger. The author's patient, a nine-year-old girl, first examined in 1943 and rechecked periodically until 1955, fits into the same pattern as 12 other cases culled from the literature. The ends of both little fingers are short and thick; they are bent radially and show rounded nails. On the roentgenogram, the terminal phalanges are deviated 10 to 50° from the long axis of the finger. The deformity starts at the epiphyseal plate, so that the diaphysis of the bone is irregular in contour, is relatively small, and shows variation in bone density. In the author's case and in all the others, follow-up studies show no advance after the original diagnosis.

A survey of all the cases shows that 10 occurred in the female, and 3 in the male. The age of onset was from the ninth to the fourteenth year of life, with the deformity present anywhere from three to six months prior to the request for medical aid. The lesions are painless and not accompanied by any sensory disturbance. There is some limitation in function for acts like typewriting and violin playing.

Etiologic interpretation is difficult because there have been no histologic studies. A juvenile osteochondrosis similar to a Perthes' disease seems quite likely, although the bilateral symmetry is a bit unusual. Bilateral aseptic necrosis must be considered. Trauma, inflammatory changes, and mechanical factors appear unlikely. Muscle pull explains the direction in which the finger deviates but gives no clue as to the cause.

Six roentgenograms; 1 table.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Secondary Ossification Centers and Epiphysis Formation of the Navicular Bone of the Foot, with Particular Attention to Their Sequels. K. H. Ueberschär. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 33–41, July 1957. (In German) (Röntgeninstitut am Städtischen Krankenhaus Moabit, Berlin, Germany)

The navicular bone of the foot is subject to variations of its ossification. Instead of one primary ossification center there are sometimes two, which may lead to the navicular pedis bipartitum, or there may be one large center and a smaller, accessory center. All of these primary ossification centers can be demonstrated between the ages of two and five years.

Sometimes, however, after the first decade of life, usually between the tenth and twentieth year, a small isolated secondary ossification center develops to complete the formation of the bone. It occurs, for the most part, along the upper proximal edge of the navicular bone, rarely along the upper distal edge. If this secondary epiphysis does not unite by the time the patient reaches the age of twenty years, it must be considered a true accessory bone. It is called os supranaviculare if located along the proximal edge, or os infranaviculare if located along the distal edge.

This simple secondary epiphysis is of little clinical significance except that it may be mistaken for a fracture. If, however, it is ragged, segmented, and divided into several pieces, the possibility of a pathological condition that may lead to aseptic necrosis must be considered. The author describes the case of an eighteen-year-old girl in whom a painful, irregular, and divided secondary epiphysis led to an osteochondritis dissecans. Apparently the divided and irregular epiphysis indicates a physiological weakness or abnormality. If this is added to the considerable strains and stress to which the upper edge of the navicular bone is normally exposed, a pathological break-down may easily occur.

Ten roentgenograms; 1 drawing.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

THE SPINAL CORD

Diagnosis and Treatment of Diastematomyelia. George Perret. Surg., Gynec. & Obst. **105:** 69–83, July 1957. (State University of Iowa College of Medicine, Iowa City, Iowa)

Diastematomyelia is a segmental longitudinal division of the spinal cord into two portions due to transfixa-

tion anteroposteriorly by a septum, either bony, fibrous, or cartilaginous, arising from the posterior surface of a vertebra. It usually involves the thoraco-lumbar region, and the diagnosis is suggested by the finding of lower motor neuron signs in the lower extremities and the presence of a tuft of hair over the lower dorsal spine. The legs may be weak and underdeveloped or may show sensory or reflex changes. Vesical and anal sphincters may function abnormally. Roentgenograms and myelograms may be made to confirm the diagnosis.

It is believed that the basic embryologic defect occurs at the fourth week of gestation, when the neural tube is being formed. Sometimes defects are found in the bony neural arch. The cleft in the cord may not always be in the midline, and at times it may extend several segments cephalad and caudad to the abnormal septum.

Roentgenographically most cases show a lumbar spina bifida occulta and an associated fusiform widening of the spinal canal. The spicule may appear as a line of increased density crossing the center of the spinal canal, or it may not be seen at all. Other spine or rib anomalies may be associated, such as hemivertebrae, incomplete segmentation, fusion of adjacent laminae or spinous processes, or narrowed interspaces.

Pantopaque myelography should be done in all cases; characteristically it shows a splitting of the medium into two columns around a fusiform central defect. This defect is usually longer and wider than the actual spur.

Treatment consists in surgical removal of the bony, fibrous, or cartilaginous septum, and mobilizaton of the cord, in order to allow its normal development and to prevent any increase in neurological dysfunction.

Five verified cases are reported.

Eight roentgenograms; 8 photographs; 2 drawings.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

THE LYMPHATICS

Primary Lymphœdema: Clinical and Lymphangiographic Studies of a Series of 107 Patients in Which the Lower Limbs Were Affected. J. B. Kinmonth, G. W. Taylor, G. D. Tracy, and J. D. Marsh. Brit. J. Surg. **45:** 1–10, July 1957. (St. Thomas's Hospital, London, England)

Kinmonth and his associates have previously described the development of a technic for visualizing the lymph vessels in normal and diseased limbs (see Brit. M. J. **1:** 940, 1955. Abst. in Radiology **66:** 311, 1956). The present report deals with the clinical and lymphangiographic findings in 107 patients suffering from primary lymphedema of the lower limbs. Three types of the condition are recognized—congenita, praecox, and tarda. In all, the essential feature is maldevelopment of the lymphatics. In 17 per cent of the authors' series a familial tendency was present, lending support to the concept of a developmental error. The causes cited by the patients, including operations of various types, injuries, etc., appear to be only precipitating factors.

The lymphangiographic observations in 87 cases are given. Aplasia of the lymph vessels was demonstrated in 12 patients; no formed lymph trunks could be found. A more common finding was hypoplasia (49 cases), with deficiency in the number or size of the vessels, or both. In 21 cases the lymphatics were broader than normal and tortuous—"varicose lymphatics"—but incompetent. In 5 cases dermal backflow was the only abnormal finding. The lymph in the dermis runs in a fine network of valveless capillaries, referred to as the "dermal plexus," and is led thence to the deeper trunks beneath the skin by collecting trunks, which are provided with valves. Normally there is no flow of lymph from the deeper trunks back into the dermal plexus. Beside the 5 cases in which such backflow was observed as the only sign of abnormality, it was present in 14 other instances.

Fourteen illustrations, including 6 lymphograms; 7 tables.

GYNECOLOGY AND OBSTETRICS

A Simple Indicator for the Uterine Cervix in Obstetric Roentgen Examinations. Stig Samuelsson and Alf Sjövall. Acta radiol. **48:** 14–16, July 1957. (University Hospital, Lund, Sweden)

The authors recommend that in instances where placenta praevia is suspected, lateral views of the pelvis be made with hairdressing clips or hairpins (of a type apparently common in Sweden) attached to the lips of the cervix. "A distance between the clip and the border of the placenta equal to or greater than 10 centimetres seems to exclude placenta praevia."

One roentgenogram; 1 photograph.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Intrauterine Determination of Fetal Maturity. Theodore W. Adams. West. J. Surg. **65:** 197–205, July-August 1957. (1020 S. W. Taylor St., Portland 5, Ore.)

In 1943, the author and his associates published a preliminary report on the use of roentgenography in the intrauterine determination of fetal maturity (West. J. Surg. **61:** 448, 1953. Abst. in Radiology **62:** 907, 1954). Further studies now make worthwhile a re-evaluation of the procedure.

Methods generally employed for determining fetal maturity are estimation of fetal size by either abdominal palpation or mensuration and roentgenographic mensuration of either the fetal length or capacity of fetal skull. From the work of Hodges (Am. J. Roentgenol. **30:** 809, 1933) and Christie *et al.* (Am. J. Obst. & Gynec. **60:** 133, 1950. Abst. in Radiology **56:** 778, 1951), it was felt that the appearance of the ossification centers in either the distal femoral or proximal tibial epiphyses, as shown by roentgenograms of the fetus *in utero*, might be a more accurate means of judging physiologic fetal development.

Studies have been carried out on 96 patients, with a total of 219 roentgenograms. Included were 54 patients with diabetes, 35 cases of repeated cesarean sections; and 7 in which cesarean section was done for such causes as repeated intrauterine death, erythroblastosis fetalis, or advancing toxemia. In addition to the films made specifically for the purpose of demonstrating epiphyseal ossification, all roentgenograms made for determining fetal presentation, of twin pregnancies and for pelvic mensuration were analyzed.

From a comparison of the figures obtained with those for Christie's series, in which the roentgenograms were made after delivery, it would seem reasonable to assume that the distal femoral epiphysis can be satisfactorily demonstrated by intrauterine roentgenography from the thirty-fifth to the thirty-seventh estimated week of pregnancy in over 80 per cent of cases. Postdelivery roentgenograms of the knee joints were made

in 48 cases in which delivery occurred within forty-eight hours of the intrauterine roentgenograms. In those instances in which the intrauterine roentgenograms demonstrated femoral ossification, there was complete agreement. If those cases in which no ossification was present are included, an accuracy of 89 per cent was obtained.

It is concluded that the absence of distal femoral epiphyseal ossification is not a *definite* indication that difficulty will be encountered in infants born before its appearance. In the present series, however, death from prematurity occurred in 7 to 13 per cent, and difficulty during the first days of life in from 17 to 41 per cent, of those babies born before ossification was demonstrable, suggesting that it is an excellent sign of sufficient physiologic fetal development to allow extrauterine life without difficulty.

Fetal ossification of the proximal tibial epiphysis was also studied, and again the figures were compared with those for Christie's series. In a high percentage of cases, this ossification center appeared at the fortieth to forty-second estimated week of pregnancy. In all estimated age groups, both the average weight and length of those babies showing proximal tibial epiphyseal ossification were definitely greater than of babies in whom ossification had not occurred, and with the exception of the estimated forty-fourth week, the average lengths and weights were all greater than those for average full-term infants. On the other hand, the average lengths and weights in babies not showing ossification were all below the average for full-term infants. It is therefore felt that this is possibly a valuable method for distinguishing "real" from "apparent" postmaturity. In those cases in which roentgenography shows no evidence of proximal tibial ossification, in the estimated forty-first week of pregnancy, it may be safely assumed that one is not dealing with true but with only apparent postmaturity. Other factors being normal, there should exist no indication for interference or cause for concern. In patients with tibial ossification at the estimated forty-first week, termination of pregnancy should be seriously considered because of increasing danger at birth from excessive fetal size or from the occasional occurrence of intrauterine death from postmature fetal placental syndrome.

The dosage of radiation received in these roentgen studies, delivered on a few weekly occasions, is considered within safe limits so far as both sterility and genetic hazards are concerned.

[Another study on ossification centers as evidence of fetal maturity (Murdoch and Cope: J. Obst. & Gynaec. Brit. Emp. **64**: 382, 1957) was abstracted in Radiology for April 1958 (p. 618).—Ed.]

Eight tables.

THE GENITOURINARY SYSTEM

Renal Arteriography in Hypertension. C. J. Hodson. Proc. Roy. Soc. Med. **50**: 539–543, July 1957. (University College Hospital, London, England)

Roentgen studies of excised kidney specimens were made following intra-arterial injections of contrast material. Definite changes were found to be associated with hypertension: (1) tortuosity of the finer branches of the arterial tree; (2) decreased numbers of intralobular vessels and arterioles; (3) narrowing of the true renal cortex. These changes cannot be effectively shown *in vivo* by renal arteriography because of the difficulty of demonstrating in satisfactory detail the small structures concerned.

In cases of hypertension in which the disease is not diffuse but is limited to a part of the kidney, the underlying pathological condition is usually a localized chronic pyelonephritis with partial renal shrinkage and scarring or, in a small number of cases, a lesion of the main renal artery. Further investigation shows that in cases of localized pyelonephritis the disease can ordinarily be satisfactorily identified and diagnosed by intravenous urography. It is in the relatively small percentage of cases in which hypertension is referable to lesions of the main renal artery that renal arteriography is a valuable diagnostic procedure. Such lesion may be embolism or thrombosis of the renal artery, intimal thickening or atheromatous change, aneurysm, or pressure from extrinsic masses. Cases in this series were examined by catheter insertion and injection of contrast material at the level of the renal arteries. It is the author's impression that hypertension does not add risk to this examination.

Six roentgenograms; 1 photograph.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Pyelorenal Backflow: Clinical Significance and Interpretation. Victor A. Politano. J. Urol. **78**: 1–8, July 1957. (Massachusetts General Hospital, Boston 14, Mass.)

Four types of pyelorenal backflow are recognized. *Pyelotubular (pyelocanalicular) backflow* has no pathological significance. *Pyelointerstitial backflow* is usually the result of extravasation or injury. *Pyelolymphatic backflow* is believed to represent lymphatic permeation of the medium from the sinus renalis. *Pyelovenous backflow* is of two types. Sinovenous ingression implies injury to a calyx and vein and must be quite rare; the more common finding is pyelovenous "transflow," which has a similar appearance but is unreproducible and apparently results from absorption through the mucosa.

The possibility of pyelorenal backflow must be kept in mind in the interpretation of intravenous and retrograde pyelograms, and extravasation of the contrast medium must be differentiated from pyelonephritis, tuberculosis, caliectasis, papillitis, and calyceal diverticulum. An important differential point is the usual inability to reproduce the changes incident to backflow on subsequent examination. The frequent occurrence of extravasations indicates, also, the importance of care in the selection of a contrast medium. Obviously, substances unsuitable for intravenous administration should be avoided or used only with the utmost care.

The role of reflux in infection, hydronephrosis, etc., is discussed, and 2 cases are reported. One illustrates the difficulty of interpreting the roentgen findings, especially on excretory urograms, and demonstrates also the routes by which infection may be carried into the renal parenchyma or perirenal space. The second case is illustrative of pyelotubular backflow, which was interpreted as caliectasis.

Ten roentgenograms. ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Hematospermia. Moreton A. Magid and James H. Hejtmancik. J. Urol. **78**: 82–88, July 1957. (1525 Colcord Ave., Waco, Texas)

In an attempt in 2 patients to visualize the seminal vesicles after catheterization of the ejaculatory ducts

and injection of 35 to 45 per cent Neo-Iopax or Skiodan, the pelvic veins, including the external iliac veins, were outlined by the contrast material and a seminal vesicle-venous communication was demonstrated. In the second patient there was filling of the right internal iliac vein and its tributaries including its junction with the external iliac vein, and the vena cava was delineated as high as its junction with the portal vein.

In each case, the presenting complaint was hematospermia. Both patients had chronic prostatitis and chronic "catarrhal" seminal vesiculitis. In both, the hematospermia responded to antibacterial therapy and treatment of the prostatitis and seminal vesiculitis by rectal massage. Thinning of the seminal vesicle walls with ulceration is postulated as the method of communication with the pelvic plexus.

Five roentgenograms. ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Thixokon: An Improved Urethrographic Medium. John Denman. J. Urol. **78:** 93–96, July 1957. (Parkland Memorial Hospital, Dallas 19, Texas)

Opaque contrast material for urethrography must meet two requirements: it must be safe if it enters the vascular system and it must be viscous enough to distend the urethra and remain in position long enough to secure an adequate radiographic record. Thixokon, developed by the Mallinckrodt Chemical Works of St. Louis, appears to satisfy these requirements. It consists of two components: a viscous aqueous vehicle and regular 50 per cent Urokon. The vehicle has the property of thixotrophy, *i.e.*, the viscosity is increased when the solution is at rest. This means that the solution may be injected with comparative ease but, once injected, its viscosity will increase and it will tend to be retained in the organ to be visualized.

The new medium has been used in 110 cases with no fatalities or allergic reactions. Visualization in 108 cases was excellent or satisfactory. There were no wholly unsatisfactory examinations.

Four roentgenograms; 1 photograph.
ROBERT S. ORMOND, M.D.
Dearborn, Mich.

The Nephrographic Effect in Depressed Tubular Excretion of Umbradil. N. P. G. Edling, C. G. Helander, and S. I. Seldinger. Acta radiol. **48:** 1–6, July 1957. (N. P. G. E., Roentgendiagnostic Department B, Karolinska Sjukhuset, Stockholm, Sweden)

The authors investigated depression of the nephrographic effect in rabbits when the noniodine containing compounds, paraminohippuric acid and phenol red, were injected prior to Umbradil. They concluded that the nephrographic effect is due mainly to concentration of iodine in the tubular cells and in the tubules and that this concentration is reduced whenever there is competition with some other substance which also is excreted by the tubular route.

Since penicillin is excreted *via* the tubules, its use may depress excretion of contrast medium and result in an unsatisfactory examination. In long standing ureteral obstructions the absence of a nephrogram may be related to the increase of metabolic substances excreted by the tubular cells, such as creatinine and hippuric acid.

Six roentgenograms. W. C. TALLEY, M.D.
University of Arkansas Medical Center

TECHNIC

The Visual Physiology of Roentgen Diagnosis. A. Basic Concepts. William J. Tuddenham. Am. J. Roentgenol. **78:** 116–123, July 1957. (3400 Spruce St., Philadelphia 4, Penna.)

Visual perception is initiated by photochemical changes which take place within the cones of the retina when they have been stimulated by exposure to light or other radiant energy. As a consequence of these photochemical changes, neural discharges are given off which ultimately result in perception. If the cones are exposed to a constant level of illumination they become "adapted" and the neural discharges decrease in number and rate. If the level of illumination fluctuates, they do not become "adapted," and they continue to actively release neural discharges.

Whenever the eye views an image, there is a minute, constant, random nystagmic motion of the eyeball. Thus, the cones which are scanning the border of the image are exposed to a rapidly fluctuating level of illumination, whereas all the other cones receive a relatively constant illumination to which they quickly adapt.

If the border of the image is an unsharp one, as is often the case with roentgenographic images of soft tissues, the differences in illumination to which the cones are exposed during the nystagmic excursions may be so slight that no perception takes place. Viewing of these unsharp borders through a diminishing lens has the effects of increasing the viewing distance. The same border is "viewed" by half as many cones, each of which is exposed to twice as great a difference in the levels of illumination, and this materially improves the perception of indistinct soft-tissue detail.

If roentgen borders are very fine and in close proximity, such as the trabecular shadows on bone roentgenograms, their retinal images tend to overlap. The cones in their excursions are exposed to a subthreshold illumination difference, and therefore cannot resolve the trabecular pattern. In such instances, a magnifying lens tends to increase the distance between the elements of the retinal image and makes resolution of the detail possible. The reading technics for perception of bone detail and soft-tissue detail are, then, diametrically opposed.

Other factors of importance are the brightness of the reader's environment and the presence or absence of distracting, noncontributory images in the neighborhood of the area under study.

Ten figures, including 2 roentgenograms; 1 table.
DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Use of Single Films Instead of Roll Film in Photofluorography. Carl Wegelius, Kaj Noschis, and Plioroze Billimoria. Indian J. Radiol. **11:** 37–44, July 1957. (Wenner-Gren Research Laboratory, Stockholm, Sweden)

The authors prefer single films to roll films for photofluorography. Single films lend themselves better to processing and filing and afford increased accuracy in diagnosis as a result of facilitated follow-up and comparative studies. It is believed that roll film may have outlived its usefulness as the incidence of tuberculosis has declined. Small films will increase in usefulness as the incidence of chest tumors and heart disease rises. The possible application of small-film photofluorography

to other studies, as of the gastrointestinal and genitourinary tracts, is mentioned.

Five photographs. JACK E. CARLISLE, M.D.
Shreveport, La.

The Duration of Fluoroscopic Examinations. G. M. Ardran, E. Emrys-Roberts, and F. H. Kemp. Brit. J. Radiol. **30:** 381, July 1957. (Radcliffe Infirmary, Oxford, England)

By inserting a clock, which automatically integrated the time of examination, into the control circuit of a radiographic unit, the authors determined the time required for various fluoroscopic procedures. The following averages were observed:

Barium meals	3 min. 48 sec.
Barium enemas	5 min. 11 sec.
Chest and heart	2 min. 35 sec.
Hysterosalpingograms	2 min. 18 sec.
Retrograde pyelograms	5 min. 34 sec.

It is believed that all fluoroscopic units should be fitted with automatic integrating clocks, so that the screening time and the factors used or the dose given could be entered in each patient's record.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Experiences of the Last Twenty Years in the Use of Microroentgenography (Historoentgenography or Historadiography) in Medical Research. F. P. Bohatirchuk. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 44–56, July 1957. (In German) (Department of Anatomy, University of Ottawa, Ottawa, Canada)

Two methods of microroentgenography are available. The first, the direct method, consists of projecting the object by means of x-rays upon an emulsion which is at some distance. The procedure is similar to the projection of lantern slides upon a screen. It involves many technical difficulties, and the indirect method is therefore preferred. This consists of taking roentgenograms of a very thin object with soft rays upon a film with very fine grain. The film is then viewed by means of an ordinary microscope.

The object, usually a biological section, must be uniform in thickness and must have a smooth surface. It should be very thin (2 to 3 micra) and free of paraffin, which would absorb x-rays. After it is thoroughly dry, the section is mounted between two thin sheets of plastic. The selection of the wave lengths of the x-ray beam depends upon the selective absorption of the specimen. The smaller the difference of the linear absorption coefficients the longer must be the wave length. The differences of absorption in the specimen can be artificially increased by treating it with radiopaque material or by injecting such materials into the circulatory system before obtaining it. Thus Thorotrast can be demonstrated in the Kupffer cells of the reticuloendothelial system two to three hours after the injection.

X-rays of from 0.8 to 5Å are being used. The author believes, however, that the so-called ultrasoft rays (more than 1.5Å) present too many technical difficulties. He uses a wave length of from 0.8 to 1.2Å, which is equivalent to about 8 to 12 kv. The x-rays are produced by a Machlett tube, Type AEG-50/A, with tungsten anode, a beryllium window, and a very small focal spot. Most ordinary x-ray transformers can be easily converted to this type of work by decreasing the primary tension of the autotransformer. Eastman Kodak spectroscopic plates 649-0 lend themselves very well to this work on account of the fine grain. If the section of the object is thin, the plate can be viewed with the microscope satisfactorily with a magnification of up to 300 times.

The author lists, without going into detail, dozens of fields in which microroentgenography can supplement the routine histologic examination or can show details that cannot be seen on ordinary microscopic examination. After working with this method for over twenty years, he feels that its advantages justify much more extensive use by anatomists, histologists, pathologists, and radiologists. With the exception of the diffraction tube, the necessary equipment is quite inexpensive.

Fourteen microroentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

RADIOTHERAPY

Tumours of the Glomus Jugulare or Tympanic Body. F. C. W. Capps. J. Fac. Radiologists **8:** 312–324, July 1957. (St. Bartholomew's Hospital, London, England)

Glomus jugulare tumors are found most often in middle-aged adults, but have been reported in patients of eighteen and eighty years. Of the author's 26 patients, 23 were women, which is in agreement with the reported sex ratio of about 5:1. The tumors have been called nonchromaffin paragangliomas to distinguish them, in respect to their tissue of origin, from chromaffin paragangliomas. The nonchromaffin groups are directly associated with cranial nerves or vessels of the branchial arches, they secrete no hormone, and probably act as chemoreceptors with afferent parasympathetic innervation from different cranial nerves. More than half of the jugular bodies are normally found in the adventitia of the jugular bulb, another fifth in the bony canal of the tympanic branch of the ninth nerve, a fourth in the mucosa covering the promontory, and some along the auricular branch of the tenth nerve beyond the jugular fossa. These variations in location can account for the different symptoms in patients with tumors. There are several reports of simultaneous carotid body and glomus jugulare tumors; since they arise in chemoreceptor organs they have also been called "chemodectomas."

The tumors consist of nests of fairly uniform epithelioid cells in a very vascular stroma, closely resembling the normal glomus. In a poorly preserved specimen degeneration can lead to an erroneous diagnosis of vascular tumor or granulation tissue. As a rule, these tumors are very slow growing and do not metastasize. Most reported deaths have been postoperative or due to direct intracranial extension.

There are two main clinical groups. In the first group the tumor arises in the tympanic cavity and eventually passes through the eardrum to present as an aural polyp. These patients complain of tinnitus, pain, deafness, and vertigo. Local removal is complicated by severe bleeding and likely to be followed by recurrence.

In the second group the tumor arises in the region of the jugular bulb and spreads along the interior surface of the petrous bone to the jugular foramen, anterior condylar foramen, and anteriorly, *via* the foramen lacerum, to the middle fossa. There is often destruction of the petrous bone, and eventually the tympanum and its contents are invaded. Thus the fifth through the twelfth cranial nerves can be involved, and symptoms related to the ear are frequently late in onset. The most common clinical errors are to attribute a bulging red eardrum to acute otitis media or to dismiss an aural polyp as granulation from chronic otitis.

Since these lesions are clinically benign, haste in treatment is not imperative. Surgical removal should be limited to the first group of tumors; radical tympanomastoidectomy is preferred. In recurrent growths and tumors of the second group radiotherapy seems to be best, and it is possible that with further evaluation it will be the method of choice in most patients. Ligation of large vessels is of little help because collaterals are quickly established. The details and results of radiotherapy are given in an accompanying article.

Six photomicrographs; 1 line drawing.

LAWRENCE A. POST, M.D.
University of California, S. F.

Radiotherapy of Tumours of the Glomus Jugulare. I. G. Williams. J. Fac. Radiologists **8:** 335–338, July 1957. (Radiotherapy Department, St. Bartholomew's Hospital, London, England)

The author saw his first tumor of the glomus jugulare in 1949. At the time of the present report he had treated 12 cases. The tumor has been considered radioinsensitive. It is slow growing, locally invasive, and nonmetastasizing. The difficulties in delivering a high tumor dose lie in the possibilities of infection and radionecrosis of the brain.

To reduce the risk of radionecrosis of bone and to increase the depth dose, x-rays generated at one million volts (h.v.l. 10 mm. Cu) were used in most of the cases. Treatment was given through oblique fields of 6 × 6 cm. to 10 × 8 cm. to reduce the dosage to the brain. A dose of 4,000 to 5,000 r was delivered in twenty-eight to forty days. Shrinkage of the tumor was obtained in all cases, and such symptoms as noise in the head, poor balance, and neurological manifestations were relieved. Deafness has remained a problem, and 2 patients had recurrence of the tumor at two and four years.

One drawing.

DAVID C. GASTINEAU, M.D.
Indiana University Medical Center

Proton Irradiation of the Pituitary. John H. Lawrence. Cancer **10:** 795–798, July-August 1957. (Donner Laboratory, University of California, Berkeley, Calif.)

This is a preliminary report of an attempt to suppress the function of the pituitary by irradiation from outside of the body. Twenty-six patients with advanced cancer of the breast were treated by proton irradiation of the pituitary. Most of these had previously had a variety of types of conventional therapy, including adrenalectomy; nearly two-thirds had undergone bilateral oophorectomy and adrenalectomy. The technic of irradiation is described.

Results in three groups of patients—those receiving 30,000 rads (1 rad being equivalent to 1.07 rep) to the pituitary, those receiving 22,000 to 26,000 rads, and those receiving 20,000 rads—are given in tabular form. There was a noticeable drop in gonadotropins over various periods of time, zero to two months, two to four months, four to six months, and six to eight months. The decrease occurred earlier with the larger doses.

There was a direct correlation of pituitary damage with dosage and time.

While tremendous doses of energy were delivered to the pituitary, and the dose to some of the surrounding structures was from 5 to 8 per cent of the total dose, no clinical signs of serious damage to this area of the brain were observed. At the higher dose levels, diplopia developed in some patients when they became tired, and ptosis occurred in a few of these; with a single exception, these conditions improved or disappeared.

In the future when hypophysectomy is indicated, the author believes it will be necessary to deliver only 24,000 rads. No visual disturbances should develop at that dose level.

So many of the patients in this series were in terminal condition at the beginning of treatment that analysis of the therapeutic results is not worthwhile. Remissions were achieved in some patients who had previously had bilateral adrenalectomy and in others whose adrenals had not been removed. Two patients were alive and doing fairly well eighteen months after irradiation.

The author concludes that it is possible to remove the pituitary by proton irradiation.

Five illustrations, including 1 roentgenogram.

Discussion on the Radiation Treatment of Cancer of the Antrum and Ethmoid. Margaret D. Snelling, B. W. Windeyer, V. M. Dalley, Robert Gibb, and C. P. Wilson. Proc. Roy. Soc. Med. **50:** 529–539, July 1957. (M. D. S., Middlesex Hospital, London, England)

This Discussion comprises a group of short papers on different procedures for the management of cancer of the antrum and ethmoids and outlines the results.

Miss Snelling advocates irradiation of the whole of the antrum to a dosage of 5,000 to 5,500 r in five to six weeks, following confirmation of the diagnosis by biopsy. One month later a palatal antrostomy is performed with removal of residual tumor and necrotic debris. If active growth remains, local intracavitary radium applicators are used in the antrum and radium needles or seeds in the ethmoids. This treatment is unsuccessful in cases where there is extensive infiltration of structures adjacent to the antrum. An analysis of failures shows the most important cause by far to be local recurrence. Consequently, an effort has been made to irradiate a somewhat more adequate volume with a higher dosage, particularly to the ethmoidal region and posterior antral area. The ipsilateral eye must be irradiated to a dangerous level, but vision is not always lost. The contralateral eye is carefully protected. Isodose curves for this set-up are given on anatomical specimens. Results have shown a steady improvement so that between 1946 and 1950 a 42 per cent five-year survival was attained in 41 cases.

Windeyer's experiences with a 1,000-curie cobalt-60 Theratron unit utilizing a 140-degree partial rotation set-up, are reported by Backhouse. The conclusions are that the set-up is unsatisfactory because of relatively low dosage to the ethmoidal and posterior antral regions and an unacceptably dangerous dosage to the contralateral eye. Experimental doses were in the range of 7,500 to 8,000 rads over a period of about six weeks.

Again isodose curves are presented on anatomical specimens.

Dalley presents a classification of tumors of the antrum based on the anatomy of the maxilla. Radiotherapy is instituted with 220-kv roentgen rays through three carefully placed fields arranged to spare the entire orbit on the normal side. The usual dosage is 4,500 to 5,000 r in five to six weeks. Direct corneal shielding is used on the diseased side. Complications following eye irradiation are discussed. Intracavitary radium may be tried for recurrent or advanced lesions. A 30 per cent five-year survival rate was achieved in 87 cases of carcinoma of the antrum and a 20 per cent five-year survival rate in 25 cases of ethmoidal carcinoma.

Gibb calls neoplasms less than 4 cm. in diameter in the antrum "early," when metastases are not evident, while tumors over 4 cm. in diameter or with metastases already present are called "late." Early antral tumors are treated by insertion of a radium tube into the tumor tissue through the canine fossa. A dose of 8,000 gamma roentgens at the surface of a sphere 2 cm. in radius, with a 25-mg. radium source is the aim. Establishment of adequate drainage is important. In 60 cases classed as "early" a 45 per cent five-year survival was achieved. "Late" cases showed only a 9 per cent five-year survival rate. Ethmoid carcinomas are treated by implants with long radium needles placed in a vertical plane about 0.75 cm. from the midline on the involved side. Needles are inserted horizontally through bone and tumor *via* preliminary drilled holes. A tumor dose of 6,000 to 8,000 gamma roentgens is calculated at the surfaces of a slab of tissue and bone 2 cm. thick. Among 5 cases so treated there were 2 survivals, a 40 per cent. All were considered early.

In cases of antral carcinoma with invasion of the ethmoid area, the intra-antral tube and the ethmoid plane implant were sometimes combined. Eight cases so treated showed a 50 per cent survival rate. "Late" cases with maxillary tumors, ethmoid tumors, or combinations showed five-year crude survival rates in the 7 to 8 per cent range.

Gibb stresses the fact that lesions greater than 4 cm. in diameter are seldom successfully treated by the antral radium tube. For these he has used a wedge filter technic with 250-kv radiations, anterior and lateral fields, and a posterior "unwedged" field. Midtumor doses are of the same general order as those previously discussed.

Wilson stresses the invasiveness of antral tumors and enters a plea for irradiation of larger volumes of tissue. He points out that the estimated volume of tissue to be adequately irradiated in the initial treatment pattern tends to be far too conservative and emphasizes this fact by noting that the average case will show spread in three directions outside the antrum when first seen. He adds a few comments on surgical management.

Thirteen figures; 8 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

X-Ray Treatment of Inoperable Cancer of the Breast. Władysław Jasiński, Andrzej Hliniak, Jeremi Święcki, and Zofia Więckowska. J. Fac. Radiologists **8**: 347–349, July 1957. (X-Ray Therapy Department, Institute of Oncology, Gliwice, Poland)

One hundred fourteen patients with inoperable breast cancer were treated at the Institute of Oncology at Gliwice, Poland, between 1947 and 1950. These cases were of Stages 3 and 4. Stage 3 comprised 32 patients in whom the tumor, irrespective of its size, was relatively fixed to the pectoral muscles, exhibited *peau d'orange*, and showed clinical signs of axillary spread. Sixty-nine cases were classed as of Stage 4; these showed further progression of the disease, with reduced mobility, skin lesions (ulceration or metastatic nodules), and one or more fixed axillary nodes, as well as more distant metastases. An additional 13 patients who had recently undergone nonradical operation elsewhere are included in this series. In 14 of the 114 patients only a clinical diagnosis was obtained.

The technic of treatment was constant, consisting in irradiation of the breast, axillary, and parasternal lymphatics. Three 15 × 20-cm. portals were used. Lateral and medial ports afforded penetration of the breast and axillae tangentially. The beam directed through the inferior port reached the axilla after including the breast and ran evenly between the other two beams. Supra- and infraclavicular areas were treated separately. The 200-kv machine used had an output of 25 r/min.; h.v.l. 1.43 mm. Cu; Thoraeus filtration.

Two portals were used daily in succession, the dosage amounting to 250 r (skin) to each, for a total tumor dose of 4,500 to 6,000 r. Treatment continued for about five weeks. The resultant moist desquamation of the skin convinced the authors that the dosages were inaccurate. They therefore made paraffin-wax phantoms in 50 cases and corrected the dosage accordingly. In none of the overdosed patients did irradiation necrosis develop.

Of the 114 patients, 20 per cent survived five years without evidence of recurrence or spread. Twenty-five per cent lived five years, irrespective of the condition of health (clinically cured with disease present). There were no infectious complications, and only 3 patients had soft-tissue necrosis, which yielded to conservative management. In 24 cases there were objective and subjective symptoms of pulmonary reaction which lasted less than six months after therapy.

GEORGE O. HOWE, M.D.
Indiana University Medical Center

The Treatment of Adenoid Cystic Carcinoma (Cylindroma) of the Respiratory Tract by Surgery and Radiation Therapy. John O. Vieta and Herbert C. Maier. Dis. of Chest **31**: 493–511, May 1957. (J. O. V., 59 East 65th St., New York 21, N. Y.)

Adenoid cystic carcinoma in the bronchial tree is identical histologically with the tumor of the same name that occurs in the salivary glands, lacrimal glands, paranasal sinuses, mouth, nose, throat, skin, and breast. The growth characteristics also are frequently similar.

The endoscopic appearance of these adenoid cystic carcinomas is variable. They may be broad and infiltrating, or polypoid. The overlying bronchial epithelium may be intact or show ulceration. The tumor frequently extends submucosally so that its extent cannot be appreciated grossly. It may extend through the wall of the trachea or a bronchus and infiltrate the adjacent mediastinal structures or surrounding lung.

The microscopic features of the adenoid cystic carcinoma are distinct. The clinical course may be protracted; metastases may occur locally or at a distance, and the prognosis is generally more serious than for the carcinoid type of adenoma or other types sometimes classified as mixed tumors of the bronchus.

A localized endobronchial tumor may cause no symptoms until it results in significant narrowing of the lumen of a bronchus or the trachea. Cough, hemoptysis, and wheezing are prominent primary symptoms.

The roentgen findings of adenoid cystic carcinoma of the bronchus are those of a slowly growing bronchial tumor. Obstructive emphysema may be observed. Infection secondary to partial obstruction and atelectasis may be found.

The treatment of choice is surgical resection. When the lesion is situated so that a lobectomy or pneumonectomy will remove the primary growth by a wide margin, the results are good. When adequate surgical resection cannot be carried out, radiotherapy may result in growth restraint. Some of these patients, treated palliatively, may live in comfort for over five years. Of 31 patients receiving radiotherapy, 6 were living without recurrence over five years; 5 died of disease in five or more years; 1 was living with recurrent disease after five years. Marked palliative benefits for inoperable cylindromas of the tracheobronchial tree can be expected in over one-third of the patients treated by radiation.

Two roentgenograms; 2 photomicrographs; 7 tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Small Dose Fractionation Roentgen Therapy in Bronchial Carcinoma and Inflammatory Processes of the Lungs. E. Kahr. Radiol. clin. **26:** 216–222, July 1957. (In German) (Zentral-Röntgen- und Radiuminstitut, Landeskrankenhaus, Graz, Austria)

The chemotherapeutic-antibiotic era was naturally accompanied by diminished use of roentgen therapy in inflammatory disease of the lung. The author, however, believes that it still has a definite and important place. He reports on 102 patients with bronchial carcinoma and 21 patients with pure inflammatory disease who were treated by his technic of small dose fractionation. After an average of three series of treatment, all 21 patients with inflammatory disease showed improvement. In the cancer cases the beneficial results are ascribed to the effect of the irradiation upon the associated inflammation.

The author comments on the poor results of intense irradiation in cancer of the lung, regardless of the various deep-therapy technics used. The condition in which many of these patients arrive for treatment contraindicates any intensive radiotherapy.

Because of their poor physical condition, 46 per cent of the author's patients with carcinoma were hardly able to complete a single radiation series and were dead within three months; 45 per cent survived three to twelve months; 7 per cent, twelve to twenty-four months; and 2.3 per cent more than twenty-four months, with an average survival of 10.4 months and an upper limit of twenty-eight months. Those with limited disease and in good general physical condition were submitted to intensive therapy.

Treatment is given through fields of 100 × 200 cm., at 40 to 50 cm. focus-skin distance, 180 to 190 kv, filter 0.5 Cu. One to 5 fields are treated, according to the size of the process. The individual dose (air) varies from 30 to 150 r. The time between series is from two weeks upward. Up to 2,000 r are given per field. This dose is well tolerated, with no side-effects.

Two tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

On Grid Therapy of Bronchial Carcinoma. Richard Haubrich and Peter Thurn. Strahlentherapie **102:** 180–193, February 1957. (In German) (R. H., Zentral-Röntgeninstitut der Städt. Krankenanstalten, Karlsruhe, Germany)

The results of surgery in 41 cases and radiotherapy in 106 cases of bronchogenic carcinoma were compared with the course of 109 untreated lesions in a series of cases observed between 1949 and 1955 at the University of Bonn. In a special analysis, the results of conventional radiotherapy (51 cases) were compared with those of grid therapy (54 cases). The findings were as follows:

Untreated Group: 104 died of carcinoma; 3 of intercurrent disease; 2 alive, nine and seventeen months later. The mean duration of symptoms prior to detection of the cancer was 6.0 months. The mean survival time after detection was 3.4 months. The total mean survival time from known onset of disease was 9.4 months (6 + 3.4).

Surgically Treated Group: 13 died postoperatively; 22 died of cancer; 6 still alive. The mean survival time after treatment was 10.8 months with surgical deaths included and 17.8 months after elimination of surgical deaths. The longest survival at the time of the report was forty-eight months. The mean duration of known disease prior to surgery was 8 months. The total mean survival time from known onset of disease was 18.6 months after exclusion of the 6 patients still living.

Irradiated Group: 100 died of cancer; 6 still alive. The mean survival times are analyzed according to the treatment, which was of three types: I. Conventional cross-fire treatment with a tumor dose of less than 9,000 r, 24 cases. II. Conventional cross-fire treatment with a tumor dose exceeding 9,000 r, 27 cases. III. Grid therapy, with less than 15,000 r tumor dose in 10 cases and from 15,000 to 25,000 r in 44 cases. The observations were as tabulated:

	Group I	Group II	Group III
Mean survival time after treatment	3.5 mos.	5.6 mos.	10.4 mos.
Duration before treatment	9.1 mos.	8.4 mos.	9.2 mos.
Total mean duration of disease	12.6 mos.	14.0 mos.	19.6 mos.

The authors add a statistical review of the results of radiotherapy and of total neglect in 4,622 bronchogenic carcinomata culled from the international literature. Therapy in this series included conventional, two-million volt, rotation, convergent beam, and grid technics.

It is concluded that surgery should be confined to squamous-cell carcinoma without metastases, whereas small-cell carcinomas should be treated with grid therapy, as should all lesions with regional metastases. Lesions with distant metastases require only palliative radiotherapy by conventional means. Grid therapy is better tolerated than rotation therapy.

In the discussion a major point is made of the fact that "early" radiotherapy does not produce any better results than "late" irradiation. It is assumed that early detection merely indicates a faster rate of growth, with

greater malignancy, so that paradoxically the life expectancy of patients with "late" detections is actually better.

[This article is valuable, also, because of its excellent statistical tables on bronchogenic carcinoma broken down according to histology.—G. S. S.]

Two figures; 4 tables.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

The Value of Irradiation in Ankylosing Spondylitis. N. Howard. Brit. J. Radiol. **30:** 371–374, July 1957. (Radiotherapy Department, University College Hospital, London, W. C. 1, England)

Increasing awareness of the individual and genetic effects produced by irradiation led the author to reconsider the therapeutic results achieved by x-rays in spondylitis. The results are based on 455 patients who received radiotherapy and were followed for more than two years.

The physical factors employed in the x-ray treatment were: 220 kv, 2.3 mm. Cu h.v.l., 50 cm. F.S.D. Treatment was given through one sacro-iliac port, 10 × 15 cm. or 16 × 12 cm., and three spinal fields, 6 × 15 cm. or 6 × 20 cm., depending upon the length of the spine. Two ports were treated daily, 150 to 200 r in air given each day for five days a week. Not more than 1,500 r was administered to the whole spine. Only 18 cases out of 100 showed reduction of white cell counts to below the level of 4,000.

Few women treated were completely free of menstrual disturbances, varying in severity from irregularity to complete cessation of menstruation. Among males loss of libido and fertility occurred but the author believes it highly probable that these were due to the debilitating effects of spondylitis rather than of irradiation. The dose received was not over 5 r to the testis, per series, and probably never over 30 r for repeated series. The dosage to the ovaries, if the patient is treated over the pelvis and hips, is higher than this.

A dose of 30 r is probably the minimal dose which will double the mutation rate. It is believed to be insufficient to harm the individual and, if confined to a small number, will produce little effect upon the population as a whole. Because of the suspected radiation hazard, the author believes irradiation of the pelvis and hip joints should be undertaken in women only when the patient is incapacitated by the disease and after all other methods have failed. In order to obtain the best results, irradiation should always be given in conjunction with physiotherapy.

The incidence of leukemia in the series reported was ten times the expected rate in untreated persons. The overall beneficial effect was around 70 per cent. Despite the increased incidence of leukemia following the use of irradiation in the treatment of spondylitis, the author believes that its use is still justified in typical cases of this disease.

One graph; 5 tables.

H. C. JONES, M.D.
Grand Rapids, Mich.

Irradiation Therapy of Pigmented Villonodular Synovitis. Milton Friedman and Emanuel E. Schwartz. Bull. Hosp. Joint Dis. **18:** 19–32, April 1957. (1016 Fifth Ave., New York 28, N. Y.)

Pigmented villonodular synovitis, as a primary lesion, is commonly found in young adults. The diagnosis is usually based on a swollen joint, aspiration of blood-tinged fluid or brownish hemosiderin from the joint space, roentgen evidence of thickened synovium with occasional nodular masses, and microscopic examination of a biopsy specimen or incompletely removed synovium.

The authors have treated 10 cases of pigmented villonodular synovitis with roentgen rays. In 8 of these, the response was satisfactory. Most of the patients with a good result were young adults. The duration of symptoms ranged from four to twenty-two months. In those cases where irradiation was successful, the tissue doses ranged from 1,326 r in eight days to 3,200 r in twenty-four days. In 2 cases, a second course of therapy was given to accelerate resolution. In 2, there was rapid and apparently complete healing within one month. Other cases required longer periods up to six months.

The 2 cases not benefited by x-ray therapy were atypical in that the pigmented villonodular synovitis was superimposed on a more serious underlying disease—in 1 an advanced degenerative osteoarthritis and in the other a post-traumatic degenerative process. The first patient received a tissue dose of 3,170 r in seventy-two days, with slight to moderate improvement for a few months, and the other, a tissue dose of 1,740 r in thirty-nine days, with no clinical improvement.

The authors conclude that in the primary lesion, uncomplicated by underlying pathology of adjacent bones, irradiation may be the treatment of choice. A tissue dose of 2,000 to 3,000 r is suggested. The prognosis is best in young adults with symptoms of only a few months duration.

The less common form of pigmented villonodular synovitis associated with a tendon sheath and invading adjacent bone is amenable to a larger dose of irradiation than that required in the conventional type.

Four roentgenograms; 3 photomicrographs; 1 photograph; 3 tables.

Results of Radiotherapy in Osteo-Arthritis of the Hip. A. H. G. Murley. Lancet **1:** 818–819, April 20, 1957. (St. Bartholomew's Hospital, London, England)

An investigation was carried out to determine the efficacy of radiotherapy in relieving osteoarthritis of the hip. To eliminate the personal factor of an interview, a simple questionnaire was sent to the patients at least a year after treatment. All the patients were either moderately or severely disabled, and all had been treated by various physiotherapeutic methods, with only partial or no relief. Fourteen were subjected to major surgery when the response to irradiation was unsatisfactory.

Of 62 patients treated, 59 were traced: 29 men, average age fifty-nine, and thirty-three women, average age fifty-eight, when treatment began. Two patients died about two years after treatment as a result of unrelated conditions; in both there had been moderate improvement, which was maintained until death. Of the remaining 57 patients, 11 (with 12 treated hips) reported subjective improvement, but this lasted for more than a year in only 5. Improvement was considerable in 3, moderate in 6, and slight in 2. The average duration of symptoms before treatment was six years. Forty-three patients could detect no appreciable benefit from the radiotherapy.

Ill effects from treatment were experienced by a few patients: 2 complained of malaise and abnormal

tiredness; 1 woman, aged forty-six, had persistent amenorrhea after treatment and complained of increased pain.

The author concludes that a dose of 1,200 to 1,500 r may be given to a hip joint in six to ten fractions in two weeks with few complications due to the treatment.

Absorbed Dose Near Bone: A Conductivity Method of Measurement. John F. Fowler. Brit. J. Radiol. **30:** 361–366, July 1957. (King's College Hospital, London, S. E. 5, England)

The author cites the desirability of measuring energy absorption directly in tissue-equivalent media. Chemical dosimetry and optical absorption changes have previously been used but not for bone tissue interfaces or cavities in bone. The present paper describes an experimental technic by which energy absorption can be measured directly in a solid tissue-like substance, with an inherently greater sensitivity than by chemical dosimetry. This consists in the measurement of electrical conductivity induced by x-rays in a thin film of plastic material (polythene). The method can be used for measuring ordinary radiotherapeutic dosage in a phantom and for the investigation of certain interface problems.

The construction of the measuring apparatus is described in detail, and the limits of its useful operation are outlined. The particular qualities of polythene which make it peculiarly suited for the work were determined under controlled experimental conditions. These are as follows: (1) Induced currents are larger by a factor of 10 to 100 than in the other common insulating substances. (2) The dark current is negligible, which is a considerable advantage, since such currents may produce troublesome polarization components. (3) The log-log plot of the induced current against dose rate is a straight line. (4) The temperature variation of induced current is only 2 to 3 per cent per 1° C.

The effective atomic number of polythene is $\bar{Z}$ = 5.44, which closely approaches that of paraffin wax ($\bar{Z}$ = 5.42). For the measuring system, consisting of 25μ polythene with 15 μ of carbon on each surface, the appropriate value of $\bar{Z}$ will be found between 5.44 for polythene and 6 for carbon; that is, approximately 5.7. This is comparable with animal fat, 5.9. It was further shown that the curve of energy absorption for polythene corresponded with the energy absorption of fat as determined by Spiers (Brit. J. Radiol. **19:** 52, 1946. Abst. in Radiology **48:** 210, 1947).

This polythene apparatus was used for measuring irradiation in the 60-kv range and below. The agreement at 60 kv is very good when compared with measurements made by the ionization chamber. The conclusion is reached that the depth dose measurements made by ionization chambers are well established, but it may be useful to use the new method to check data at lower voltages.

The author also devised an experiment to simulate the measurement of dose absorption close to a bone-fat interface. Glass (assumed $\bar{Z}$ = 12.3) was used to simulate bone ($\bar{Z}$ = 13.8), and polystyrene ($\bar{Z}$ = 5.66) to simulate fat in contact with the polythene detecting element. In view of the necessarily approximate nature of the comparison, the results obtained with this material should be sufficiently accurate to satisfy the requirement in our present state of knowledge. A glass microsopic slide was fixed back-to-back with a slab of polystyrene of the same dimensions. The double slide was placed in contact with the carbon electrode, first with the glass side down, and afterward with the polystyrene down, so that the glass was beyond electron range from the polythene detecting film. The primary radiation flux was the same in both cases, and the difference due to scattered radiation was very small. The two induced currents could then be used to estimate the required ratio at that quality of radiation. The results of the experiment showed good general agreement, especially with the later and more comprehensive calculations. (Woodard and Spiers: Brit. J. Radiol. **26:** 38, 1953).

Nine figures; 1 table.

H. C. JONES, M.D.
Grand Rapids, Mich.

The Mineral Content of Bone Tumors and Its Influence on Radiation Tumor Dose. Helen Q. Woodard and Ralph Phillips. Am. J. Roentgenol. **78:** 109–115, July 1957. (H. Q. W., 444 East 68th St., New York 21, N. Y.)

This is the report of a study conducted to determine whether, in the radiation treatment of bone tumors, x-ray wave length significantly affects the biological response.

During irradiation of tissue, the calcific material which is present contributes secondary electrons which produce more ionization effects. The most heavily calcified portions usually contain the least amount of actively metabolizing tumor tissue. Therefore, chemical measurements of the quantities of tissue alkaline phosphatase and tissue calcium in different parts of a tumor permit a fairly accurate estimation of the amount and distribution of radiation in the tumor or tissue.

Because calcium contributes to the secondary irradiation, there is a proportional relationship between the amounts of energy absorbed and the kv peak at which the roentgen rays are generated. However, the x-rays of longer wave length are absorbed more in the least active parts of the tumor, and so do not appreciably add to the tumor dose. The x-rays of shorter wave length are little absorbed by calcium, and consequently are less likely to damage normal bone.

Since the healthy functioning of normal bone cells is important in recovery from radiation therapy, the short wave length radiations are preferable for treatment. It is doubtful whether different wave lengths have any other effect upon the biological response

The foregoing is based upon tissue studies performed on 27 patients. One to 4 specimens were studied in each case. The series included 20 sarcomas, 1 osteochondroma, and 6 cases without bone disease.

One roentgenogram; 1 diagram; 1 table.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Experimental Studies on the Irradiation of Homogeneous and Inhomogeneous Media Through a Perforated Grid. H. G. Ebert, H. Finke, and R. Sigmund. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 76–79, July 1957. (In German) (Institut für medizinsche Physik und Biophysik, Gosslerstr. 10, Göttingen, Germany)

If a field of irradiation is divided into many small individual fields by the use of a perforated grid, a much larger dose can be applied. If this method is combined with a multiple port technic, a depth dose of from 9,000 to 14,000 r can be delivered to the seat of the disease.

Through the divergent distribution of the primary x-rays, the grid is projected into the seat of the disease,

but with increase in depth the secondary rays will produce a certain degree of equalization. The desirability of this equalization is still a matter of controversy. Some authors try to achieve a rather homogeneous distribution of the rays, while others consider it desirable to retain a network of areas receiving little irradiation, from which regeneration can start. Most of the measurements that have been published in the literature regarding the quality of the radiation after passage through a perforated grid were made in water, *i.e.*, in a homogeneous medium. The media, however, that exist in the human body are not at all homogeneous. In thorax irradiation, for instance, the ribs will absorb the rays to a much greater extent than the air-containing lungs.

The authors have made careful studies of the homogeneity of the irradiation through a perforated grid in a homogeneous medium (water) as compared to an inhomogeneous medium (thorax). They used: 200 kv, h.v.l. 2 mm. Cu, and a 10 × 15-cm. grid with round holes 1 cm. in diameter. Forty per cent of the grid surface was perforated. The conditions in the thorax were closely approximated by a model in which the thoracic wall and the mediastinum were made of a substance M_3 (closely resembling the absorptive qualities of the thoracic wall), and the lungs were made of felt. The results of their measurements were traced on a graph. It can be shown that in a homogeneous medium the rays soon assume homogeneity. In the thorax, however, the rays show a variable attenuation. Therefore, in irradiating the thorax through a perforated grid, the usual standard tables of depth attenuation cannot be used.

One graph. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Subtotal and Total-Body Irradiation Through a Grid. Iván Rodé and László Bozóky. Strahlentherapie **102**: 277–287, February 1957. (In German) (Staatl. Onkologische Institut, Budapest, Hungary)

By means of a projection grid (lead plate with multiple perforations) mounted into the master cone of orthovoltage deep-therapy machines, it is possible to increase the radiation tolerance of cancer patients spectacularly. "Subtotal" 40 × 40-cm. fields could be treated with up to 200 r per day, to a total of 3,000 r, without radiation sickness or significant blood changes. With total-body radiation the daily dose must not exceed 30 r and the total dose must be smaller than 150 r because of the fall in the leukocyte count. This is claimed to be still slightly higher than is possible without the lead grid in the filter slot.

Nine figures; 1 table.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

Measurements of Relative Beta Depth Doses in "Tissue Equivalent" Material. Gunnar Walinder. Acta radiol. **48**: 68–80, July 1957. (Institute of Radiophysics and Radiumhemmet, Karolinska Sjukhuset, Stockholm, Sweden)

The author has investigated a measuring method for the determination of beta depth doses in wet tissue from semi-infinite isotope solutions. For the measurements he used Au^{198}, P^{32}, and As^{76}.

The first step in the study was the substitution of a phantom material for wet tissue. The interaction between electrons and medium consists principally of inelastic collisions (ionization is the main reason for energy loss) and elastic collisions (scattering). A substitute for wet tissue, therefore, must have similar properties in respect to energy absorption and scattering. The author derives a mathematical expression for the mean scattering angle of electrons and finds, together with Bethe-Blochs formula for energy absorption, the following conditions for the substitution for water (wet tissue) from the standpoint of beta radiation: $(Z/A)_{\text{eff.}} = (\sqrt{[Z(Z+1)]}/A)_{\text{eff.}}$ when Z = atomic number and A = atomic weight.

Calculations are carried out for water, gelatin, triacetate, scintillation crystal, Lucite and Mix D [60.8 per cent paraffin wax ($C_{25}H_{52}$), 30.4 per cent polyethene n(CH), 6.4 per cent MgO, and 2.4 per cent TiO_2], which all have values for $(Z/A)_{\text{eff.}}$ and $(\sqrt{[Z(Z+1)]}/A)_{\text{eff.}}$ which are relatively close to those of water.

A special scintillation probe was designed for the measurements. The scintillation crystal is sidewise, surrounded by Mix D; above the crystal is water. The inside of the container for the isotope solution, which is made of Lucite, may be either cylindrical or semispherical. This container can be moved within the surrounding water in any desired distance from the crystal. Since the use of a very small scintillation crystal may be the source of different errors, the author uses a crystal 2 cm. in length, which is longer than the maximum range of the electrons. The measurements are based upon the difference in the photomultiplier current for two different depths of water (depth was changed in steps of 0.1 mm.). The difference between the scintillation effects in the two positions is equal to the scintillation effect in a cylindrical volume given by the diameter of the crystal and the shift length. For shifts of 0.1 mm. this difference in the measurement can be assumed to be proportional to the dose in the very small volume of the shift.

The author has calculated the dose in the axis outside of a cylindrical phantom containing isotope solution. He finds that the ratio between gamma and beta doses at the surface of the phantom is 0.021 for As^{76} and 0.076 for Au^{198} (cylinder surrounded by a medium which is equal to the solution itself in a radiation sense).

Measurements were carried out also with films (Cine Positive 5302). As the back-scattering by the AgBr layer will be increased, a film with a very thin AgBr layer was chosen (0.72 mg/cm²). A rough estimate shows that the increase of back-scattering by the AgBr layer is less than 2 per cent of the total number of incident electrons.

The film values and the scintillation values agree quite well.

Seven figures. WALTER MAUDERLI, D.Sc.
University of Arkansas Medical Center

Energy Deposition in Tissue and Similar Materials by 14.1-Mev Neutrons. M. L. Randolph. Radiation Res. **7**: 47–57, July 1957. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

A method is developed for the calculation of the ratio of dose rate to 14.1-MEV monoenergetic neutron flux produced by the $H^3(d,n)He^4$ nuclear reaction, taking into account known nonelastic reactions and the angular distributions for neutron scattering, for materials with specified composition of H, C, N, and O. The values of d_i, the energy dissipation per nucleus per unit flux, for these elements are found to be roughly constant (the heavier elements—C, N, and O—are very nearly

equivalent per gram). Typical results, probably accurate to within less than ±5 per cent, for a number of hydrogenous materials are presented. Applications of these results include determination of dose rate from flux measurements, correction of dose values resulting from ionization measurements in nontissue-equivalent materials, and means of determining tissue equivalence. Further analysis discloses that higher average LET (linear energy transfer) values obtain than if heavy nuclear products are ignored. For this and other neutron energies, more accurate and detailed knowledge of elastic and nonelastic reactions and the energy dissipation by heavy particles is needed.

Four tables. AUTHOR'S SUMMARY

RADIOISOTOPES

Radioactive Isotopes in the Diagnosis and Treatment of Cancer. Guest Editorial. L. Henry Garland and John H. Heald. J.A.M.A. **164:** 1096–1098, July 6, 1957. L.H..G., 450 Sutter St., San Francisco 8, Calif.

Some twenty-one years have elapsed since the first use of artificial radioactive isotopes in cancer diagnosis and treatment. Enthusiasts were initially hopeful that in the near future the profession might witness outstanding examples of selective localization of radioactive materials in neoplastic tissue, making it easy to detect such lesions and possibly providing a means of delivering tumor doses much higher than would be received by the adjacent normal tissues. Up to the present time, however, only two radioactive isotopes have been developed to provide important therapeutic applications through relatively selective localization—radiophosphorus (P^{32}) in polycythemia vera and radioiodine (I^{131}) in a small percentage of thyroid carcinomas. This fact has confirmed the belief of many that the greatest contribution of radioactive isotopes in the field of cancer lies in tracer applications. Nevertheless, isotopes do have a place in diagnosis and therapy. The authors attempt to summarize present concepts in this respect. They conclude "It may be stated that, when used judiciously and with sound indication, radioactive isotopes have a definite but limited place in the diagnosis and treatment of certain forms of cancer. As research continues, more extensive and practical uses will probably be found for these substances. At the present time, however, their chief value remains in tracer work, for which they are uniquely suited as an investigative tool."

Graphic Interpretation of Isotope Localization of Intracranial Lesions. Shelley N. Chou and Lyle A. French. J. Neurosurg. **14:** 421–429, July 1957. (S. N. C., 60 S. Fourth St., East, Salt Lake City, Utah)

In the routine interpretation of radioisotope encephalometry, the presence of an intracranial lesion is determined by noting asymmetry of the counts by approximately 10 per cent or more. Such method of approach poses two problems: (1) Midline lesions could be missed, due to symmetrical increases in radioactivity to both sides of the cranium. (2) Peripherally located cystic lesions with low uptake of the tracer might be misinterpreted as a focus of increased activity on the opposite side. For these reasons, a new method of interpretation was devised based upon comparison of the radioactivity over specific areas of the sides of the head with that of an established normal range for these sites.

The "normal graph" was established by analysis of 27 radioisotope encephalometric records which were considered normal. The subjects were given radioactive iodinated serum albumin in the amount of 5μc/kg. and counts were made twenty-four hours later. An arithmetical mean of each of the routine 24 cranial positions, as well as of the total counts, was thus obtained to determine the normal graph. There was a variation up to 40 per cent in the absolute counting level for any given position in different individuals given the same tracer dose per body weight. Therefore, in any specific case under study, it is necessary to convert the counts per unit time for each position by the ratio of the mean value of the normal total counts to the total counts of the specific case.

The normal, or general graph, can be separated into six symmetrical graphs representing 3 coronal and 3 sagittal planes of the cranial hemispheres, each called a sectional analysis graph. By this method of sectional analysis, the graphs are more easily interpreted in regard to anatomical locations, and on comparison with an individual case in which an abnormality is present, the deviations from the normal values appear graphically more evident.

Eighty-seven per cent of neoplasms, porencephalic cysts, and acute vascular lesions were correctly localized by the method of graphic analysis as compared with a correct localization of 68 per cent by the routine technic of asymmetry. Small lesions, especially those without associated cerebral edema (*i.e.*, most pituitary tumors) and posterior fossa tumors still present a difficult problem of localization either by routine isotope encephalometry or the method of graphic analysis.

Eleven graphs; 1 drawing.

DAVID FOXMAN, M.D.
Cleveland City Hospital

The Determination of the Velocity of the Circulation in the Leg Arteries by Means of Radioisotopes as a Preparation for Serial Angiography. H. D. de Reus. Fortschr. a. d. Geb. d. Röntgenstrahlen **87:** 41–43, July 1957. (In German) (Wilhelminapark 19, Apeldoorn, Netherlands)

The author believes that of the various technics of angiography of the leg direct radiography on large films is by far the best. He feels that in the indirect method of photographing a fluoroscopic image on 35-mm. or even 70-mm. film, many important details are lost. In order to obtain the optimal time sequence for the radiographic exposure in serial angiography the knowledge of the velocity of the circulation is of inestimable value.

An attempt was made to determine this velocity by means of radioisotopes. Prior to the angiography a small amount of radioisotope is injected into the aorta. Three counting devices are placed between the legs of the patient. The first is aimed at the groin, the second at the knee, and the third at the ankle of the diseased leg. These are hooked up with a time-recording device in such a manner that in the beginning only the first counting device is in the circuit. As long as no radio-

active material is going down the leg, a straight line is recorded. As soon as the radioactive material reaches the field of vision of the first counting device in the groin, a deflexion is recorded. This deflexion automatically disconnects the first counting device and places the second one in the circuit. The recording drum will correctly measure the time until the second counting device records the arrival of the isotope at the knee. Similarly, the third counting device will record the velocity in the lower leg, which may be much slower due to mechanical obstacles in the arteries. Thus the optimal time for the exposures can be determined.

The author is now working on a plan to inject the contrast material together with the isotope and to have the counting devices themselves activate the radiographic exposure at the moment of the arrival of the contrast material.

As isotopes the author uses Na^{24}, which is harmless but has only a short half-life (14.8 hours), or I^{131}, which has a half-life of eight days but is being deposited in the thyroid gland. It is necessary to saturate the thyroid with inactive iodine before using radioactive iodine.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Measurement of the Active Iodine Stores and Daily Hormonal Output of the Intact Human Thyroid. John H. Nodine, Bertram J. Channick, Demetri Sokhos, Shirley Dresner Tassoni, and William H. Perloff. J. Clin. Endocrinol. **17:** 832–841, July 1957. (Temple University School of Medicine, Philadelphia 40, Penna.)

Studies of glands removed at operation or at autopsy have shown a positive correlation between functional states of the thyroid and thyroidal iodine stores. Data so derived, however, are not applicable to the living patient except in a general way. An experimental method which would allow such studies *in vivo* would be helpful, both in understanding the pathogenesis of thyroid disease and in determining the type and amount of treatment required.

Tracer doses of radioactive iodine which are fixed in the thyroid gland can be released into the blood stream along with stable hormonal iodine in response to administered thyroid-stimulating hormone (TSH). By comparing the specific radioactivity of the newly secreted hormone with the thyroidal content of I^{131}, it is possible to estimate the hormonal stores of the intact human gland. In a method devised by the authors, the specific radioactivity of the newly secreted protein-bound iodine (PBI) is determined directly, so that equilibration of thyroidal and extrathyroidal PBI compartments is not necessary for valid hormonal store calculations. By means of this method, the thyroidal stores of I^{127} were determined in 10 euthyroid subjects. These stores averaged 5.26 mg. of I^{127} per gland—a value somewhat lower than those determined by chemical technics. However, the rate of secretion of hormonal I^{127} when estimated by this method averaged 56 micrograms per day, which is in close agreement with some other estimates. Although the discrepancy in the thyroid gland hormonal content as shown by these findings and those of some other investigators may be attributed to random variation or to technical factors, it is also possible that inactive, unmeasured, and physiologically unrepresentative I^{127} stores are present in the normal human thyroid.

One graph; 2 tables.

Some Results of Radio-Iodine Diagnostic Tests for Thyroid Function. D. Brinkley, J. L. Haybittle and K. J. Plested. Acta radiol. **48:** 33–51, July 1957. (Addenbrooke's Hospital, Cambridge, England)

The authors' investigations of radioiodine tests of thyroid function included the maximum percentage uptake, half-life of the iodine in the thyroid gland, and the estimation of plasma and protein-bound I^{131} concentration at forty-eight hours.

The study covered 110 tests in 99 patients. The normal doses administered were from 70 to 100μc of carrier-free I^{131}. Measurements were made with a Geiger-Müller counter 50 cm. from the neck. The difference between two counts, one made with a 10 × 10 × 5-cm. lead block in front of the thyroid and one without, was taken as indicating the activity of the gland. For calibration purposes, four models of thyroids of different volume, placed in a cylindrical water tank, and containing known amounts of iodine, were used. The counts per minute and per μc showed only a relatively small change with change of volume.

The cases were divided into two groups, those with previous treatment and those without, and then classified as hyperthyroid, euthyroid, and hypothyroid. The statistical distribution of the results within these groups was investigated, and the percentage overlap between hyperthyroid and euthyroid groups was calculated. The authors conclude that the discussed tests leave much to be desired as a guide to treatment in cases where the clinical picture is not clear.

Under the best conditions, misleading results are likely to be obtained in some 20 per cent of cases. To distinguish between hyperthyroid and euthyroid patients, the maximum percentage uptake gives slightly better results than the forty-eight hour protein-bound iodine activity. Both tests are superior to the measurement of the forty-eight-hour total plasma activity. It was found, furthermore, that the results in untreated cases are better than in those cases having had some treatment (surgery, I^{131}, or drugs).

As the upper limits for the normal thyroid, the following figures are given: 55 per cent maximum uptake; total activity in plasma after forty-eight hours, 0.5 per cent per liter; protein-bound iodine activity after forty-eight hours, 0.27 per cent per liter of plasma.

None of the tests offers much help in the differentiation of hypothyroid and euthyroid patients, except that a maximum uptake below 20 per cent is strong evidence of myxedema. A large number of patients with myxedema, however, show higher values.

The effective half-life of the isotope in the gland has little diagnostic value.

Two diagrams; 5 tables.

WALTER MAUDERLI, D.Sc.
University of Arkansas Medical Center

Outline of Early Radioiodine Uptake Tests for the Assay of Thyroid Function. T. H. Oddie. M. J. Australia **2:** 11–15, July 6, 1957. (Royal North Shore Hospital, Sydney, Australia)

A description and discussion of the physical, physiological, and mathematical principles underlying assay of thyroid function with radioiodine are given, with comments on these factors as they affect the accuracy of the assessment. The article is a technical one, which should be consulted by those interested in this subject.

Conclusions drawn include the following: "Only badly overlapping results can be expected for border-

line groups of patients unless a good experimental technique is maintained." With a careful and painstaking technic, sufficient statistical accuracy in counting can be attained to give a reliable index of thyroid status. The elimination of errors arising from radioiodine in the nonthyroid tissues of the neck is important in reaching an accurate assessment. Radioiodine measurements, unlike basal metabolism determinations, are not affected by the emotional state of the patient. However, the basal metabolism rate is still useful in determining metabolic status of patients under the influence of thyroid-affecting medications, which usually interfere with I^{131} results. Follow-up investigation of patients who have received I^{131} therapeutically is another application of a precise uptake test.

Results are given for repeated measurements on one euthyroid subject.

Six figures; 1 table. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Salivary Excretion of I^{131} in Various Thyroid States. J. A. Stein, Y. Feige, and A. Hochman. J. Lab. & Clin. Med. **49**: 842–849, June 1957. (Rothschild Hadassah University Hospital, Jerusalem, Israel)

The salivary radioiodine excretion in various thyroid states was measured in 70 patients twenty-four hours after administration of a tracer dose of I^{131}. In each patient, the concentration of inorganic and protein-bound plasma radioiodine was determined, as well as thyroid uptake and urinary excretion of the isotope.

High salivary I^{131} concentrations were consistently found in hypothyroid subjects, decreasing as thyroid activity increased. Salivary I^{131} concentration varied considerably in clinically euthyroid patients, though the mean values obtained in each of the functional states were distinctly apart.

A practically constant ratio was found between the mean values of salivary I^{131} and plasma inorganic I^{131}, regardless of thyroid state of the patients, furnishing further evidence of the biologic relationship of these two entities. Though appropriate for diagnostic purposes, the salivary to protein-bound plasma I^{131} ratio does not reflect any intrinsic biologic relationship.

The determination of both salivary and total plasma I^{131} concentration may be satisfactory for estimation of thyroid activity by tracer methods. It is more convenient from practical considerations than the usually practiced determination of protein-bound I^{131} conversion ratio and may furnish equivalent diagnostic information.

Sources of error with special regard to variation of salivary flow rate, as well as limitations inherent in the method, are discussed.

Two graphs; 2 tables.

Marked Depression of the Plasma Protein-Bound Iodine Concentration in the Absence of Clinical Hypothyroidism During Testosterone Medication. Hans G. Keitel and Max G. Sherer. J. Clin. Endocrinol. **17**: 854–861, July 1957. (H. G. K., Jefferson Medical College, Philadelphia 7, Penna.)

The administration of steroids, including estrogens, cortisone, and prednisone, has been shown to be associated with changes in the level of circulating protein-bound iodine, the thyroidal iodine uptake, and plasma thyroxine-binding capacity. In an investigation carried out by the authors, 13 women and children were given either testosterone propionate intramuscularly or methyltestosterone orally for periods usually ranging between six and nine weeks. In 12 subjects, there was a reduction in the level of plasma protein-bound iodine—in 9 instances to within the range observed in hypothyroidism. In 8 of the 10 cases in which determinations were made before and after therapy, the twenty-four hour thyroidal I^{131} uptake decreased following the administration of testosterone. In no patient was there clinical evidence of hypothyroidism. The possible mechanisms accounting for the low concentration of circulating protein-bound iodine in the absence of clinical signs of hypothyroidism are discussed.

Three illustrations.

Pathogenesis of a Case of Congenital Goiter with Abnormally High Levels of SPI and with Mono- and Diiodotyrosine in the Serum. Sidney C. Werner, Richard J. Block, Richard H. Mandl, and A. A. H. Kassenaar. J. Clin. Endocrinol. **17**: 817–831, July 1957. (S. C. W., Presbyterian Hospital, New York 32, N. Y.)

An unusual case is reported of congenital goiter with mild hypothyroidism in a five-year-old colored girl. The patient was admitted to the hospital because of enlargement of the thyroid, known to be present for two years. At first no family history of goiter was obtained, but later it was learned that a goiter had developed in a distant cousin of about the same age. The serum precipitable-iodine (SPI) level was approximately 25 μg. per 100 ml. Upon paper chromatography, after labeling with I^{131}, the SPI was found to be equally distributed among monoiodotyrosine, diiodotyrosine, triiodothyronine, and thyroxine. Studies of thyroidal and peripheral dehalogenation of labeled diiodotyrosine revealed the presence of dehalogenase activity in nearly normal amounts.

The authors believe that the best hypothesis to explain these findings is that there was failure of coupling of diiodotyrosine, and that this failure was caused by an enzymatic defect.

Ten illustrations; 5 tables.

The Experimental Production of Thyroid Tumors in the Rat by the Administration of Sodium-5-Iodo-2-Thiouracil. William L. Money, John T. Godwin, and Rulon W. Rawson. Cancer **10**: 690–697, July-August 1957. (Sloan-Kettering Institute for Cancer Research, New York, N. Y.)

The authors have investigated the possibility that the prolonged ingestion of iodothiouracil, unlike thiouracil, would not result in the formation of thyroid tumors in experimental animals.

Fifty young mature rats of the Sprague-Dawley strain and 50 young female rats of the Wistar strain were given 0.1 per cent iodothiouracil in drinking water for as long as twenty-five months. At various intervals of time during the study, animals received an intraperitoneal injection of 5 or 25 μc. of carrier-free I^{131} and were killed by exsanguination from the dorsal aorta twenty-four hours later. Radioactivity of dissected thyroids was determined by gamma counting of samples in a well-type scintillation counter.

The prolonged administration of sodium-5-iodo-2-thiouracil to rats produced marked changes in the thyroid glands. Although the thyroid weight increased over control values, frequently only a slight effect on glandular structure was noted, even after

many months of treatment. Shortly after the start of iodothiouracil therapy, the primary effect was involution of the follicular cells and increased storage of colloid. During this time large numbers of macrophages were observed in the follicular colloid. After approximately a year of treatment, thyroid tumors were frequently found. These tumors neither attained the size of those previously obtained with thiouracil alone nor did they collect I^{131} to the same degree.

Twelve photomicrographs; 1 table.

Relationship Between Cerebral Vascularity and P^{32} Uptake. Louis Bakay. Arch. Neurol. & Psychiat. **78:** 29–36, July 1957. (Massachusetts General Hospital, Boston 14, Mass.)

Previous experiments have shown that various portions of the brain exchange radioactive phosphate with the plasma at very different rates. The most rapid exchange was observed in the superficial layers of the cortex and in the ventricular lining. This was explained by the proximity of the cerebrospinal fluid, which acted as an intermediary in the transport of P^{32} from plasma to brain, though the great number of capillaries in the cortex as compared with that in the white matter could not be disregarded as a contributing factor. The present experiments were carried out mainly to study the cerebral P^{32} concentration in bloodless brains.

Following a single intravenous injection of P^{32} in cats, the fastest cerebral uptake was found in the choroid plexus and area postrema. In the nerve tissue proper, the most superficial layer of the cerebral and cerebellar cortex and the lining of the ventricular system revealed the highest isotope concentration. No direct relationship was found between the rate of phosphate exchange of various portions of the brain and their relative vascularity.

A rapid saline perfusion of both carotid arteries performed from thirty minutes to three hours after the injection of P^{32} failed to change the amount and regional distribution of the isotope in nerve tissue. The P^{32} content of the choroid plexus, and possibly that of the area postrema, was reduced by perfusion.

The exchange of P^{32} between plasma and brain increased in cats which died of anesthesia after a prolonged period of hypoxia or anoxia. Under such conditions the regional distribution of the isotope followed more closely the pattern of the cerebral capillary network. In the author's opinion it can be assumed that in the central nerve tissue a linear relationship between relative vascularity and rate of phosphate exchange is in itself a pathological phenomenon.

Twelve photographs of cross sections of brain, with corresponding radioautographs.

Use of Radiophosphorus for Bone Vascularity Determinations. Patrick G. Laing, Albert B. Ferguson, Jr., Laverne Vaughan, and Mary Grebner. Arch. Surg. **75:** 31–34, July 1957. (A. B. F., Jr., Children's Hospital, 125 De Soto St., Pittsburgh 13, Penna.)

A study was made of the problems encountered in attempts to utilize uptake of P^{32} for determination of bone vascularity or viability. Fifty microcuries of P^{32} were injected into the ear veins of rabbits. After ninety minutes the animals were sacrificed and blood and bone samples were taken. Fragments of bone were obtained from the epiphyseal, metaphyseal, and diaphyseal areas of the femurs and tibias, and a control or reference sample was taken from the midshaft of the humerus. The bone fragments were carefully prepared by cleansing, removal of soft tissues, incineration, pulverization, and determination of radioactivity with suitable scaling equipment. Results on 10 animals are reported in tabular form. The conclusions are that the vascularity of the metaphyseal areas is significantly greater than of the epiphyseal areas, in most instances. In both of these locations activity was much greater than in the cortical bone of the midshaft. Technical and theoretical difficulties in these determinations are commented upon.

One diagram; 1 table. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Radioactive Cobalt Therapy of Mikulicz Syndrome Associated with Leukemia. Nikola Laktić and Kazimir Trogrlić. Radiol. clin. **26:** 239–244, July 1957. (In German) (Ophthalmologische Abteilung und Onkologische Institut des Krankenhauses "Dr. Mladen Stojanović," Zagreb, Yugoslavia)

This is a case report of a 57-year-old woman with leukemic infiltration of the eyelids, causing considerable impairment of vision. Radiocobalt therapy to the spleen resulted in improvement in the blood picture and general condition, but it was not until the isotope was applied directly to the lids that vision improved. The diminution in the infiltration of the eyelids was then almost immediate.

Details of the hematologic course are given.

Two photographs. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Effects of the Injection of Colloidal ^{198} Gold in Malignant Effusions. Gwen Hilton, K. E. Halnan, N. Howard, and B. E. Godfrey. J. Fac. Radiologists **8:** 339–346, July 1957. (University College Hospital and Medical School, London, England)

This paper is an attempt to assess the result of colloidal Au^{198} therapy for malignant effusions in 109 patients seen at University College Hospital, London.

Patients in the terminal phase of their illness did not benefit; in fact, the end sometimes seemed to be hastened. Patients in good general condition with rapid reaccumulation of fluid after aspiration are best suited for this type of therapy. Those with large masses or adhesions and loculations failed to respond. Seedling growths under 5 mm. in diameter on the pleural or peritoneal surfaces were treated to inhibit tumor growth and fluid formation. Implantation metastases may be prevented by gold therapy after rupture of a cystic tumor at operation.

The histology of the primary lesion did not seriously influence response to treatment. Effusions associated with lymphomas regressed even after external irradiation had failed.

Doses of 80 to 100 millicuries of Au^{198} were instilled into a single pleural cavity, and 100–150 mc. into the peritoneal cavity. Injection is made through a cannula inserted into the chest or abdominal wall. It is never made through a surgical incision for fear of leakage. The distribution of the gold in the cavity is checked by a gamma survey monitor.

Of 48 patients observed for one week after treatment, 24 had no reaction; 18 had slight reactions in the form of regional pain, nausea, vomiting, and anorexia; in 4 reactions were marked, lasting four days to a week, and in 2 severe, extending over several weeks.

Loss of colloidal gold in the urine and feces was negligible; about 10 per cent was concentrated in the liver in five days. The effective biological half-life is 31.7 days, with a loss of 2.2 per cent per day. Plasma activity increased to levels of about 0.2 per cent per liter per day and 0.04 per cent per day was excreted in the urine, giving a renal clearance rate of about 0.2 liters of plasma per day. The bone marrow concentration is no higher than this. Occasional excretion of up to 2 per cent per day was found in the sputum.

Up to 60 per cent of the injected dose of radioactive gold was recovered from the fluid aspirated from the pleural cavity, and up to 20 per cent from the peritoneal cavity two weeks after injection. Much of this activity may be in floating cells.

Of 94 cases analyzed for results, 40 showed cessation of fluid formation for two months to two and a half years (12 after two injections); 8 showed a moderate response, and 25 no benefit. Twenty-one patients died in less than six weeks. Nineteen patients with bronchial carcinoma showed good response after one treatment, 2 others required second injections; none required further aspiration.

Duration of improvement was 6.6 months in bronchial cancer, 7.2 months in ovarian cancer, and 8.4 months for breast cancer patients. Of 9 patients treated postoperatively, 3 died of recurrence of disease in two and a quarter years: 2 patients in whom seedlings had been seen and 1 of 3 who were treated after rupture of a cyst at operation.

As to nursing precautions, only the sputum and aspirated fluid should be regarded as sufficiently radioactive to create a hazard.

Five figures; 1 table.

J. A. CAMPBELL, M.D.
Indiana University Medical Center

Distribution of Radiosulfur, S^{35}. I. In the Human Adult. II. In the Young and the Adult Rat. Charles W. Denko and Robert E. Priest. J. Lab. & Clin. Med. **50:** 107–112, July 1957. (C. W. D., University Hospital, Ann Arbor, Mich.)

The distribution of radiosulfate in the tissues of an adult human female with widespread carcinomatosis was studied following the intravenous injection of S^{35}-labeled sodium sulfate. Studies were also made of the quantitative distribution of S^{35} in the tissues of young and adult rats following the intraperitoneal injection of the same material. In general the structures known to contain sulfated mucopolysaccharides, especially the connective tissue containing chondroitin sulfate, showed the highest concentration of S^{35}. In the human adult, the structures with greatest level of radiosulfur were the rapidly growing tumor (carcinoma of the breast), red bone marrow, mucosa of the gastrointestinal tract, cartilage, kidney, and aorta. Appreciable levels were noted in the bone and in the endocrine glands. Low amounts were found in the muscle, nervous tissue, and fat. In the rat the structures with high S^{35} deposition were cartilage, bone, aorta, and tendon. Other organs and tissues with appreciable amounts of S^{35} were kidney, skin, gastrointestinal tract, eyecoats, lung, and pituitary. Changes attributed to aging were reflected by a decreased total radiosulfate in the tissues and, in some structures with increasing amounts of connective tissue, higher levels of S^{35} proportionally.

Two tables.

The Effect of 17-Ethyl-19-Nortestosterone (Nilevar) on the Uptake of Radiosulfur in the Fractured Humerus in the Rat. K. Kowalewski and F. Gouws. Surg., Gynec. & Obst. **105:** 1–4, July 1957. (Edmonton, Alberta, Canada)

Certain hormone deficiencies manifest themselves clinically by osteoporosis, spontaneous fractures, or growth arrest, effects which may be partially alleviated by steroids that promote protein anabolism. The best known of these is testosterone. It would appear that such drugs might favorably influence healing in bone injuries if one could be found which did not produce masculinization.

The authors of this paper conducted a study along these lines, by administering Nilevar (17-ethyl-19-nortestosterone) to 35 castrated rats, in each of which one humerus had been fractured. One group of animals received 20 mg. of the hormone, and one group 50 mg., in three weeks, which would represent the period of healing of the fracture. Two untreated control groups were maintained, one of normal rats and one of castrates. Radiosulfur (S^{35}), which binds itself to certain elements of collagen in the process of cartilage formation, was given to each rat three weeks after fracture. The rats were later sacrificed, and measurements of callus formation and of radiosulfur uptake in the extremities were made.

All rats showed higher S^{35} uptake in fractured than in intact bone. The castrated rats, however, showed less uptake than did the uncastrated rats. Nilevar administration during healing stimulated S^{35} uptake considerably above the levels noted in untreated animals.

Nilevar thus evidently does stimulate synthesis of certain elements of cartilage. The larger the dose, in this experiment, the greater was the response observed.

One graph; 2 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Use of Radioactive Iodinated Serum Albumin in the Localization of Intracranial Lesions. Richard B. Rhody and Gerald R. Nowlis. J. Neurosurg. **14:** 413–420, July 1957. (G. R. N., Mason Clinic, Seattle, Wash.)

The localization of intracranial pathological processes by iodinated human serum albumin (RISA) utilizes the differential "pooling" of this substance by those tissues which possess a capillary intima with different properties of permeability than capillaries of normal brain tissue.

A time interval of twenty to thirty hours after intravenous injection of 500 microcuries of RISA in adults and proportionately smaller amounts in children was found to be the optimal time for localization studies with a scintillation counter. Of several methods of scanning tried, use of a counter mounted on a flexible arm so that it could be held perpendicular to the head proved to be the most satisfactory. A tight-fitting cap upon which numbers were placed was worn by the patient and 25 to 30 paired positions were counted.

A statistical analysis of 50 patients studied by this method is offered; 45 subsequently were proved to have intracranial pathological processes. In 36 cases, the lesions were located by the RISA study.

Comments concerning the results of the localization experiments correlated with the surgical and pathological findings are presented. The authors state that this procedure is not yet sufficiently reliable for use

to the exclusion of other standard diagnostic tests, but that it appears worthy of further investigation.

One photograph; 1 table. DAVID FOXMAN, M.D.
Cleveland City Hospital

Blood Volume Fluctuations Determined by Radioisotopes of Chromium and Radioactive Iodinated Serum Albumin. J. Richard Thistlethwaite, William A. Spencer, and Salomon N. Albert. Surg., Gynec. & Obst. **105**: 34–38, July 1957. (W. A. S., George Washington University Hospital, Washington 7, D. C.)

Serum albumin tagged with radioactive iodine (RISA) can be used to measure blood volume. Three to 4 microcuries diluted in 20 c.c. of saline are injected intravenously, and 10-c.c. blood specimens which are withdrawn later are used to calculate blood volume according to the following formula:

$$\text{Blood volume} = \frac{\text{Counts of standard} \times \text{c.c. administered}}{\text{Counts of specimen} - \text{background}}$$

The tagged serum albumin soon begins to enter the "albumin pool of the peripheral tissue spaces," viscera, thyroid, etc., so that, except for early determinations, the results are inaccurate and reflect a volume greater than that of the central circulating blood.

If a 20-c.c. suspension of red cells is tagged with 20 microcuries of radioactive chromium (Cr^{51}) and is given intravenously, blood volume determinations can be made by use of the same formula in the same way. These determinations are more reliable, particularly where serial determinations are to be made.

The effects of intravenous fluids, of hypotension, and of blood loss upon blood volume were studied, and fluctuations of blood volume were noted in normal subjects and in patients during the operative and postoperative period. Normal subjects showed increase of as much as 500 c.c. following meals or ingestion of large quantities of fluids. In three to four hours blood volume returned to normal.

Intravenous infusions of normal saline or 5 per cent glucose in distilled water produced transitory blood volume increases. Glucose, if given rapidly, evidently had an osmotic effect and often increased the blood volume by more than the amount given.

When hypotension was induced with Arfonad, blood volume was seen to increase, and the hematocrit fell. When hypertension was induced with neosynephrine, the blood volume decreased and the hematocrit increased.

For about forty-eight hours following rapid bleeding, serial determinations revealed gradual hemodilution (increasing blood volume), and a falling hematocrit.

Surgical blood loss can be measured by this method if a multiple dose technic is used. It is essential that blood pressure be stable, that there be no active bleeding at the time of study, and that at least fifteen minutes elapse between isotope administration and blood withdrawal for counting.

The authors do not state whether this work was performed in man or on animals, nor are any indications given as to the numbers of subjects or determinations.

Five figures. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

The Site of Absorption and Tissue Distribution of Orally Administered ^{56}Co-Labelled Vitamin B_{12} in the Rat. C. C. Booth, I. Chanarin, B. B. Anderson, and D. L. Mollin. Brit. J. Haemat. **3**: 253–261, July 1957. (Postgraduate Medical School of London, Ducane Road, London, W. 12, England)

Rats killed at varying time-intervals, from fifteen minutes to fourteen days, after receiving a single oral dose of 0.0025 μg. of $Co^{56}B_{12}$ of high specific activity, were found to have absorbed between 19 and 55 per cent of this material. The radioactivity in the wall of the small intestine was maximal between fifteen minutes and two hours after the oral dose. The greatest proportion of the radioactive material was found to be in the middle segments of the small intestine during this time.

The appearance of radioactivity in the blood was delayed for one hour after the oral dose; the peak concentration was at four hours. The increase in B_{12} concentration in the blood was equivalent to 1.3 $\mu\mu$g. of $Co^{56}B_{12}$ per milliliter.

Radioactivity in the liver, kidneys, and remainder of the carcass did not increase until one to two hours after the oral dose. Peak levels were reached between six hours and two days. Slightly greater amounts of radioactive material were found in the liver than in the kidneys. The remainder of the body contained more radioactivity than the liver and kidneys together.

Five charts; 2 tables.

RADIATION EFFECTS

Radiation Exposure of Pediatricians. P. J. Valaer and M. R. Zavon. Am. Indust. Hyg. A. Quart. **18**: 35–41, March 1957.

The equipment and work habits of 44 pediatricians employing fluoroscopes in private practice were investigated in an attempt to assess the exposure to ionizing radiation. Since several men shared offices, the study actually covered 34 fluoroscopes, of 14 different makes. Time-of-use information was obtained on 29 of the machines by means of a time totalizer designed expressly for the purpose. Sixteen fluoroscopes were in operation for less than one and a half minutes a week and three for more than seven minutes (maximum: 11.75 minutes a week). Each pediatrician wore a laboratory coat with 10 pocket chambers while using the fluoroscope during the week of investigation.

The chambers worn by 31 pediatricians recorded less than 50 mr. Those of 5 pediatricians, however, went beyond the 200 mr chamber scale. Measurement of the useful beam rates disclosed 6 fluoroscopes exceeding 20 r per minute. The highest was 37.5 r per minute. The reading for 16 machines ranged from 10 to 20 r per minute, and for 12 it was less than 10 r per minute. Five pediatricians showed some evidence of radiation damage to the skin of the hands or feet or both.

While most of the exposures were low compared with present maximum permissible standards, this can be attributed to the low work load rather than to intrinsic protection or to good technic. In the pediatricians receiving the highest exposure, there was a recognizable and remediable cause. Three of these wore no protective garments. One used a hand fluoroscope. Many of

the men did not own the red goggles for dark adaptation.

Measures for decreasing the radiation exposure are discussed.

The Influence of Oxygen on the Radiosensitivity of Mammalian Tissues. E. A. Wright and P. Howard-Flanders. Acta radiol. **48:** 26–32, July 1957. (Hammersmith Hospital, London, England)

The authors irradiated the tails of week-old mice and measured the amount of growth over a three-week period when the tissues were made anoxic by compression and when the animals were breathing partial pressures of oxygen. Both roentgen radiation at 190 kv (h.v.l. 1.5 mm. Cu) and beta radiation at 1.6 MEV were used. Partial pressures of oxygen were varied from one-half atmosphere of air to three atmospheres of oxygen. Localized anoxia was produced by a pressure cuff which surrounded the entire tail.

The results are nicely charted and may be summarized as follows:

(*a*) If the lowest radiosensitivity obtained with anoxia produced by the pressure cuff is taken as unity, the relative radiosensitivity increases to 2.6 when the partial pressure of oxygen in the respired gas is maximal.

(*b*) "Following blanching of the tail by pressure, the radiosensitivity falls by a factor 1.8 in the course of four seconds. It stops at the reduced value for so long as the blood is occluded. If the circulation is permitted to return, the radiosensitivity rises rather more slowly, reaching the former value within thirty-five seconds."

The authors caution that the administration of oxygen during radiotherapy may increase the sensitivity of normal tissue as well as tumor tissue. Bones have a preferential energy absorption from 250-kv roentgen irradiation and bone necrosis following radiotherapy is a well known hazard. Whether there is an increase of radiosensitivity of human bones analogous to the findings in the growing bones of mice is not determined, but it is suggested that, in giving oxygen, it might be advisable to restrict the total dose if the field includes bone. The authors also speculate that "in some tumors. . .greater advantage might be obtained if all the tissues of the body were made anoxic during a short period of irradiation, and if the dose was raised appropriately."

One photomicrograph; 2 diagrams.

HOWARD J. BARNHARD, M.D.
University of Arkansas Medical Center

Treatment of Murine Leukaemia with X Rays and Homologous Bone Marrow. Preliminary Communication. D. W. H. Barnes, M. J. Corp, J. F. Loutit, and F. E. Neal. Brit. M. J. **2:** 626–627, Sept. 15, 1956. II. D. W. H. Barnes and J. F. Loutit. Brit. J. Haemat. **3:** 241–252, July 1957. (D. W. H. B., M.R.C. Radiobiological Research Unit, Harwell, Berks., England)

In their preliminary communication the authors report the results of three similar experiments designed to test the hypothesis that a dose of x-rays sufficiently lethal to normal cells of the bone marrow and lymphatic tissues to cause death of the animal might well be completely lethal to leukemic cells. The irradiated animal could then be treated with normal isologous bone marrow from the same strain of mouse for the repopulation of the hematopoietic and lymphopoietic tissues.

A generalized lymphoid leukemia (151/1) was induced in the CBA mouse by passage of cells intravenously or subcutaneously. One week later the mice were given whole-body x-irradiation in doses approximating the LD 100. Some animals were then treated with intravenous injections of isologous (CBA) myeloid tissue in order to recolonize hemopoietic and lymphopoietic tissue; in a few, homologous bone marrow from other strains of mice was employed. Mice receiving 950 rads at high intensity (fourteen minutes) were not cured of leukemia. When the dose was increased to 1,500 rads and the time extended to twenty-five hours, however, 25 mice out of 35 were alive after three months.

One table.

In the second paper, the authors describe a continuation of the above studies. As 950 rads was found to be less than the LD 100 for leukemic cells, experiments were conducted (1) to determine whether replacement of the irradiated hematopoietic tissues with homologous rather than isologous tissue would effect destruction of the residual leukemic cells and (2) to discover whether homologous material from animals immunized against CBA leukemia is more effective than natural homologous material.

A dose of 950 rads given at a high dose rate—the LD 98 for the normal CBA mouse—was insufficient to eliminate all the malignant cells. When recovery from the radiation syndrome was effected by the administration of isologous myeloid tissue, the animals died after about one month, usually with overt leukemia.

When the radiation syndrome was treated with homologous bone marrow, the animals often survived for longer periods but died in a wasted condition without signs of leukemia. This might indicate destruction of the residual leukemic cells by the homograft or failure of these cells to grow in an animal poorly nourished because of delayed effects of radiation damage of the gut.

One chart; 5 tables.

Leukemoid Blood and Leukocytes in Treatment of Radiation Lethality. L. H. Smith and C. C. Congdon. Arch. Path. **63:** 502–507, May 1957. (Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tenn.)

The authors found that injections of leukocytes of leukemoid blood from BALB/c mice produce recovery of lethally irradiated BALB/c mice. The number of animals surviving thirty days or more was directly proportional to the number of leukocytes injected. One hundred per cent survival was usually obtained with 100.0×10^6 or more leukocytes. Neither erythrocytes nor platelets of leukemoid blood enhanced the thirty-day survival.

The data suggest that the mode of action of leukemoid blood in the treatment of radiation lethality is similar to that of bone marrow.

In the present investigation, heterologous leukocytes from normal rats and rabbits and from man with leukemia proved ineffective in the treatment of irradiation injury in mice.

Two photomicrographs; 4 tables.

Effects of Total-Body X-Irradiation on the Susceptibility of Mice to *Escherichia coli* Endotoxin. Jay P. Sanford and Howard E. Noyes. Radiation Res. **7:**

58–64, July 1957. (Walter Reed Army Institute of Research, Washington, D. C.)

Infection may be an important contributing factor to mortality during certain phases of the syndrome which follows total-body x-irradiation. The present studies were undertaken to ascertain whether an increase in susceptibility to endotoxin occurred after sublethal irradiation and whether changes in susceptibility to endotoxin were correlated with the appearance and disappearance of leukopenia. If an early increase in susceptibility to endotoxin occurs, the prompt control of Gram-negative infections in individuals with traumatic wounds and concomitant irradiation assumes increased importance.

Rockland albino strain mice were used in two experiments; in a third, four strains of mice were compared. The endotoxin was injected intraperitoneally. In the first experiment mice were exposed to 200 r total-body x-irradiation, which was sublethal. Relatively small groups of animals were studied at frequent intervals from the first to the twenty-first day postirradiation. Only moderate leukopenia developed, with a fall from control leukocyte values of 10,000 to 12,000 per cubic millimeter to an average of 3,000 per cubic millimeter by the third day and return to average control values by the eighth to tenth day. No significant increase in susceptibility to *E. coli* endotoxin was observed when the irradiated animals were compared with the controls housed in the same jars. A general trend toward increased susceptibility over the twenty-one-day period was noted in both groups.

In two experiments the amount of irradiation was increased to 400 r (LD 37/30 and LD 39/30). This exposure uniformly resulted in leukopenia and weight loss. As in the previous experiment, no increase in susceptibility to the endotoxin was observed in the irradiated groups of mice as compared to the control groups, even though marked leukopenia occurred in the latter.

Three tables.

Experimental Treatment of Total-Body Irradiation Injury. A Brief Review. C. C. Congdon. Blood **12**: 746–754, August 1957. (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

The experimental treatment of total-body roentgen irradiation injury by the injection of living blood-forming cells has been extensively studied. Injection of bone-marrow cells has been found to be effective also in lethal external gamma and fast neutron exposures.

The amount of bone marrow or other blood-forming tissues introduced after a lethal dose of radiation determines the percentage of survival. The effective cell type, or types, in the administered tissue has not been clearly determined. Since dividing cells are necessary, the stem cells and reticulum cells of the hematopoietic tissue are implicated.

The intravenous route of injection produces the best results. Intraperitoneal, intrapleural, and intrasplenic injections are also effective, but not intramuscular or subcutaneous. The administration of bone marrow may be delayed until three or four days after irradiation, or even longer.

It has been established that there is localization of injected cells in the damaged blood-forming tissues. Here they multiply and produce peripheral blood elements of the donor type.

Experiments have been performed with homologous and heterologous as well as with isologous marrow. This is feasible since there is a temporary loss of the immune response of the recipient following irradiation.

Secondary reactions appeared in many animals after apparent recovery from the radiation effects. These secondary phenomena, referred to as delayed foreign bone marrow reactions, are characterized by progressive loss of weight, terminating in death. The observed changes are interpreted as representing a reaction of the animal's immune mechanism to the foreign bone marrow and blood elements.

A number of unrelated, nonliving materials, ranging from ground glass to inactivated virus, seem to influence survival from radiation injury at some exposure levels. No adequate explanation for the results observed exists at the present time. The search for nonliving materials that will duplicate the recovery from lethal irradiation caused by injection of living blood-forming cells remains a vital area of advancement of the treatment of irradiation injury.

One graph; 1 table. ROBERT S. ORMOND, M.D.
Dearborn, Mich.

Genetic Factors Influencing Irradiation Protection by Bone Marrow. I. The F_1 Hybrid Effect. Delta E. Uphoff. J. Nat. Cancer Inst. **19**: 123–130, July 1957. (National Cancer Institute, Bethesda, Md.)

Previous experiments in tumor transplantation have shown that F_1 hybrids produced by crossing two inbred strains of mice will grow tumors progressively if the tumors are indigenous to either parental strain or to the specific F_1 hybrid. In the present investigation, however, it was found that when F_1 hybrid mice are exposed to a lethal dose of x-radiation and treated with bone marrow, the F_1 marrow affords better protection than either of the parental strains. This phenomenon is called the "F_1 hybrid effect."

The results of the inoculation of parental marrow are similar to those found when homologous marrow is used. Death occurred during the secondary phase of the irradiation and was marked particularly by extreme diarrhea and emaciation.

There was a positive correlation between the histocompatibility gene locus, H-2 (the "strongest" known histocompatibility locus), and the ability to protect the recipient during the secondary phase.

Evidence at present indicates that an immune response of the graft against the host, when the graft and host have different histocompatibility genotypes at the H-2 locus, is responsible for the secondary phase of the irradiation syndrome.

Five tables.

Chemical Protection against Ionizing Radiation. I. Sampling Methods for Screening Compounds in Radiation Protection Studies with Mice. A. W. Kimball, W. T. Burnett, Jr., and David G. Doherty. Radiation Res. **7**: 1–12, July 1957. (W. T. B., Oak Ridge National Laboratory, Oak Ridge, Tenn.) **II. Mercaptoalkylamines and Related Compounds with Protective Activity.** David G. Doherty, W. T. Burnett, Jr., and Raymond Shapira. Ibid. pp. 13–21. **III. Mercaptoalkylguanidines and Related Isothiuronium Compounds with Protective Activity.** Raymond Shapira, David G. Doherty, and W. T. Burnett, Jr. Ibid. pp. 22–34.

Part I: In animal experiments designed for testing large numbers of compounds for protective action

against radiation, sampling methods are needed that provide the maximum amount of information with the fewest possible animals. Each compound must first be tested for toxicity, as manifested by convulsions or death, and then for protective action. In the present paper, sampling methods employed by the authors are described. For toxicity tests, the "up-and-down" method provides a precise and economical means of estimation. According to this method, a set of doses, usually equally spaced on a log scale, is chosen *a priori*. One animal is injected at a dose believed to be close to the LD 50. If this animal dies, a second is injected at the next lower dose; if the first animal lives, the second is injected with the next higher dose. This procedure is continued until a predetermined number of animals have been tested. The LD 50 can be estimated, usually within 5 per cent, with only 10 animals. For the same precision other methods could easily require 50 or more animals.

In radiation protection tests the method of sequential analysis is preferable to fixed sample size methods. Control is provided over risks of falsely judging compounds as protective and of failing to detect a compound that is protective. The method is easy to apply, and in many cases the decision for each compound is based only on the difference in numbers surviving in the treated and control groups.

Part II: Thirty amino and substituted aminosulfhydryl compounds were tested in mice for protective activity against a lethal dose of x-radiation. The most effective compounds in providing survival against a single 800-r dose of x-rays were 2-mercaptoethylamine, its disulfide, and 3-mercaptopropylamine. The hypothesis is advanced that these compounds are protective by virtue of their direct reaction with radiation-induced radicals to form resonance-stabilized hybrids that react preferentially with other radicals and not with sensitive biological material. The structure essential for activity in this class of compounds appears to consist of an amino group separated by not more than three carbon atoms from a sulfhydryl or disulfide group.

Part III: A series of 16 isothiuronium compounds, 27 amino or substituted aminoalkylisothiuronium salts, 13 thiazolines, and 18 mercaptoalkylguanidines were tested for toxicity and screened for protective activity against a lethal dose of x-radiation to mice.

The hypothesis is made that, on a molar basis, those mercaptoalkylguanidines capable of forming five- or six-membered cyclic intermediates will be the most active protective agents.

2-Mercaptoethylguanidine and 3-mercaptopropylguanidine were found to be more active and less toxic than 2-mercaptoethylamine, with a therapeutic ratio of about 2 to 1. The two compounds, 2-mercaptoethylguanidine and 3-mercaptopropylguanidine, could be readily prepared in a pure state from the corresponding aminoalkylisothiuronium salts.

One figure (Part III); 11 tables.

Acute Lethality Studies with the Rat: The LD_{50}, Death Rate, and Recovery Rate. Henry I. Kohn and Robert F. Kallman. Radiation Res. **7**: 85–97, July 1957. (Radiological Laboratory, University of California School of Medicine, San Francisco 22, Calif.)

FAC(I) F_1 rats, ninety-six to two hundred and twelve days old, were irradiated once with 250-kvcp x-rays (h.v.l., 1.6 mm. Cu) at a tissue-dose rate of 30 r/min. Of the deaths that occurred during postirradiation *days 0-40*, 98 per cent occurred prior to *day 29*. For the pooled data of six experiments, the LD 50 was 570 ± 7 r and the slope function of the dose-effect curve was 1.12 ± 0.01. After the LD 48, the mean killing time was ten days; after higher doses it fell below ten days.

The rate of prompt recovery was determined with a method in which a nonlethal injuring dose (315 r) was given on *day 0* and the residual injury was determined from the changes in the LD 50(28) at various times up to *day 21* thereafter. Recovery was an exponential function of time; for 50 per cent recovery the time was 4.9 days. As recovery proceeded, both the mean and the standard deviation of the killing time tended to increase. Judged by mean killing time, at twenty-one days after the injuring exposure the rats were more varible in their response to x-rays and, on the average, slightly more resistant.

The results of experiments using a comparable design for the study of prompt recovery after whole-body exposure were reviewed. In seven kinds of mice and two kinds of rats, recovery on *day 1* and thereafter could be treated as an exponential function of time, but the rates differed by as much as a factor of 5. In the hamster, the function was not exponential; in the monkey it was assumed to be exponential. It was noted that genetic and other factors, including the magnitude of the injuring dose, may influence the recovery process.

Four graphs; 3 tables.

Effects of Rapid Massive Doses of Gamma-Rays on the Testes and Germ Cells of the Rat. J. F. Spalding, J. M. Wellnitz, and W. H. Schweitzer. Radiation Res. **7**: 65–70, July 1957. (Los Alamos Scientific Laboratory, Los Alamos, N. Mex.)

Mature male rats were exposed to 2,500, 5,000, 10,000, 20,000, 50,000, and 100,000 r of gamma-radiation from a 27,000-c Ba^{140}-La^{140} source at dose rates in excess of 1,000 r/min. The pathological changes in the testes were observed at time intervals of 0 to forty-eight hours after exposure.

The time between gamma-ray exposure and the appearance of general testicular pathogenesis was shortened as the total dose was increased, but the type of degeneration observed in the germinal components did not differ from those which occur as a result of low dose and low dose rate exposures.

Two types of giant cells were present in quantity twenty-four hours after exposure: multinucleated, originating from prespermatocytes, and uninucleated, with a large amount of cytoplasm. The latter type appeared to be formed from secondary spermatocytes.

Type A spermatogonia appeared to be radioresistant, as cells of this type were present when most of the germ cell component was in an advanced stage of degeneration.

Sperm cells in the tail of the epididymis were radioresistant and appeared morphologically normal and motile as long as forty-eight hours after exposure at all dose levels.

Six photomicrographs.

In Vitro Effects of X-radiation on White Blood Cells and Blood Platelets. Richard Wagner, Norma Meyerriecks, and Carroll Z. Berman. Blood **12**: 733–745, August 1957. (R. W., Tufts University School of Medicine, Boston 7, Mass.)

The authors undertook to study two different enzy-

matic reactions of leukocytes *in vitro* to roentgen irradiation: alkaline phosphatase and dehydrogenase activity. Experiments on blood platelet respiration were included because it was impossible to obtain active leukocytes without admixed platelets. In addition, studies of the glycolytic cycle following large radiation exposure were carried out.

In the experiments on phosphatase activity, the leukocytes were isolated from citrated horse blood, resuspended in plasma, counted, and exposed to x-rays, usually 50,000 r. Prior to the phosphate determination, the cell suspension was frozen, thawed, then dispersed and crushed in a homogenizer. In the experiments on dehydrogenase activity, the cells were simply resuspended in plasma.

For irradiation, the cell suspension was placed in a depression in a paraffin cylinder, where it was considered to receive a uniform dose at all points. Usually 50,000 r of unfiltered 120-kv roentgen radiation was delivered in twenty minutes and forty seconds. In some experiments, the dose was smaller: 5,000, 10,000, 15,000, 20,000, and 25,000 r.

Alkaline phosphatase activity of leukocytes was enhanced by irradiation, while cell respiration of leukocyte-platelet suspensions was depressed. The characteristic aging curve of phosphatase activity was accentuated but was not altered in principle. The x-radiation effect is not comparable to mechanical injury to the cells. It is suggested that the rise in phosphatase activity of leukocytes after radiation may be explained on the basis of changes in the cell envelope, *i.e.*, changes in the physiochemical state of the cell surface.

The endogenous oxygen uptake of leukocyte-platelet suspensions is reduced by approximately 20 per cent by exposure to x-radiation of as little as 5000 r. The addition of substrates such as sodium succinate or α-glycerophosphate diminishes this effect of irradiation.

In pure blood platelets, a similar decreasing x-radiation effect occurs for endogenous respiration as well as succinic dehydrogenase activity; α-glycerophosphate dehydrogenase activity, on the other hand, is enhanced.

While the percentage radiation decrease of pure leukocytes is unchanged for endogenous and succinate activity, the decrease for α-glycerophosphate as substrate reaches considerably higher levels (68 per cent compared with 8.2 per cent in leukocyte-platelet suspensions). Thus, α-glycerophosphate dehydrogenase activity seems to be most sensitive to x-radiation.

No essential difference in lactic acid formation and glycogen content between radiated (5,000 r) and nonradiated leukocytes in three experiments carried out in an atmosphere of nitrogen was noted. Hexokinase activity did not show any change in glucose disappearance after radiation.

Three graphs; 3 tables.

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Dual Morphologic Reactions of Rabbit Lymphocytes to X-Rays. Robert Schrek. Arch. Path. **63**: 252–259, March 1957. (Tumor Research Laboratory, VA Hospital, Hines, Ill.)

Rabbit lymphocytes were irradiated *in vitro*, incubated at 37° C., and studied by time-lapse cinemicrography. After 10,000 r, some of the cells showed early degenerative changes, including irregularities in the shape of the nuclei, which in some instances were of clover-leaf, appearance, and bilobed. In one to three hours, all cells were dead, as indicated by loss of oscillatory and rotational movements, rounding up of the nucleus, and increased transparency of the nucleoplasm. The cells, however, retained many of their morphologic characteristics. This type of death was called delayed fixation.

After irradiation with 1,000 r, the lymphocytes died by intranuclear vacuolation, lobulation, and pyknosis. With intermediate doses (2,000 and 4,000 r), some cells died by delayed fixation, some by intranuclear vacuolation, and a few by a combined process. The two types of death suggest that x-rays produce two distinct types of cellular injury.

Six cinemicrographic reproductions; 1 table.

The Effect of X-Irradiation on the Plasma Lipid Fractions of the Rabbit. N. R. Di Luzio and K. A. Simon. Radiation Res. **7**: 79–84, July 1957. (N. R. Di L., University of Tennessee, Memphis, Tenn.)

Plasma lipid partition was studied in rabbits after 1,000 r of midbody x-radiation. Elevations in plasma "neutral fat," cholesterol, and phosphatide were observed in all the irradiated animals. The magnitude of the increases in all the plasma lipid fractions in the animals dying two to four days after irradiation was significantly greater than the increase noted in the survivors. These findings add further support to previous observations that have indicated that hyperlipoproteinemia and plasma opalescence after irradiation are unfavorable prognostic signs.

Two tables.

Modification of the Biologic Effect of Radiation by the Application of Protective Agents after Exposure. Matthias Krahe, Hans A. Künkel, and Hans-Joachim Schmermund. Strahlentherapie **102**: 288–290, February 1957. (In German) (Universitäts-Frauenklinik, Hamburg-Eppendorf, Germany)

Others have shown that with total-body irradiation of 700 r there is a latent period of up to three weeks if the exposed animal is maintained in hibernation from the time of exposure. Cysteine administered during this period affords definite protection. In analogy to this, seeds of *Vicia faba* were exposed to 3,000 r (200 kv, 0.5 mm. Cu, 600 r/min.). Forty-one hours later cysteine or cysteamine was applied to the nutrient solution. The mitosis rate of the seeds thus treated was about equal to that of nonirradiated seeds, whereas those seeds which were irradiated but not protected exhibited a 50 per cent reduction of mitosis.

One table.

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